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A FINITE ELEMENT PREPROCESSOR FOR SAP IV AND ADINA.(U)

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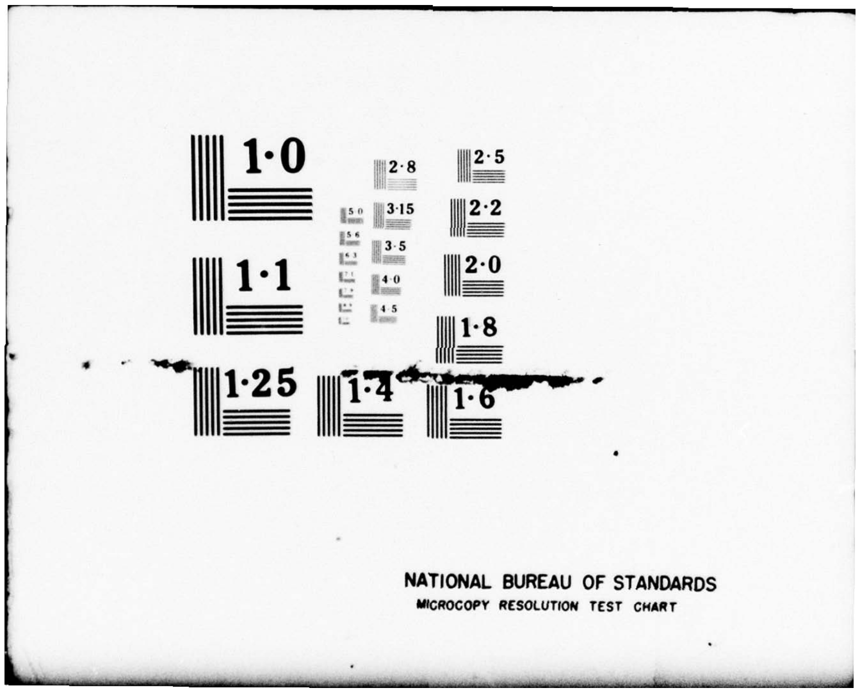
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NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A FINITE ELEMENT PREPROCESSOR
FOR SAP IV AND ADINA

by

Adrian Earl Kibler, Jr.

September 1977

Thesis Advisor: G. Cantin

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(20. ABSTRACT Continued)

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A Finite Element Preprocessor for SAP IV and ADINA

by

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The primary purpose of this thesis was to provide a method of checking the geometry and element connectivity input data for two finite element programs, ADINA and SAP IV. This preprocessor will accept the ADINA or SAP IV data deck, with minor modifications, and generate a graphical display of the finite element model. The display is an oblique orthographic projection, and any orientation may be specified. Several options are available: exploded plots, partial plots, node numbering, element numbering, and others. Elements with three nodes on the same edge are plotted with a continuous curve on each edge generated by an interpolated parabola. Displacement postprocessing capability also exists.

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I. INTRODUCTION

A. GENERAL

The continued developments and advancements of the finite element method this last decade have provided greater machine capabilities than ever before. Here at the Naval Postgraduate School (NPS), two of the more favorable finite element programs are SAP IV [reference 1] for linear analysis and ADINA [reference 2] for nonlinear analysis. However, with the large amounts of numerical input/output data and automatic mesh generation, it is impractical to check and reduce this data without a graphical representation. Data checking is divided into two areas: preprocessing and postprocessing.

1. Preprocessing

Preprocessing is the checking of the input data deck. Errors in a finite element program occur basically in two areas. First, how close is the mathematical model (boundary conditions, loading conditions, material properties, etc.) to the real problem? Second, are numerical errors present, or did misinterpretation of instructions occur in data deck preparation? Of the second type, most common errors are found in the geometry and element connectivity data. Preprocessing includes the forming of a graphical representation of the finite element model on which geometry and element errors are easily detected. When

node and element numbering options are available, the graph aids in the physical interpretation of the output data. Preprocessing is not a foolproof method of eliminating errors, but it does provide a tremendous advantage to the user. Preprocessors may be incorporated into the data check mode of the finite element program. However, to modify a large and complex program is dangerous. This may not be the best approach. A safer method is to develop a preprocessor which will read the finite element program deck separately with minimum modifications to that deck.

2. Postprocessing

Though not as important as preprocessing, postprocessing is extremely helpful in output analysis. Probably the most common and useful type of postprocessing is the contour plot. Appendix C of reference 4 lists a program developed to produce contour plots of stress data from finite element models. Contour plots can easily be adapted to a 2D system, but 3D requires plotting the contours on 2D surfaces, a bit more complicated. Two methods of postprocessing of displacements are the plotting of a deformed model or placing scaled vectors at the nodes. In the cases where the displacements are small, multiplication by a magnification factor produces an exaggerated representation. Like preprocessing, postprocessing can be incorporated into the finite element program directly, or done separately. When done separately, the finite element program must still be modified slightly to obtain a punched deck of the stresses

and displacements in the desired format. This thesis is primarily concerned with preprocessing.

B. HISTORY OF DEVELOPMENT OF PSAP1

A package [reference 4] containing digital computer programs for generating oblique orthographic projections and contour plots was produced by the National Aeronautics and Space Administration's (NASA) Langley Research Center (LRC) and distributed by the National Technical Information Service in January, 1975. The programs are completely general. Both programs contain options for selecting various plotting equipment including CALCOMP, VARIAN, and cathode ray tube (CRT) displays. With minor modifications, they can be adapted to most any system.

1. SUBROUTINE PSAP Implementation

Losh [reference 6], for his master's thesis in aeronautical engineering, implemented the preprocessor and postprocessor program, PSAP, at NPS in December, 1976. Modifying the LRC package [reference 4], Losh adapted SUBROUTINE PSAP to the NPS IBM 360/67 system using the CALCOMP model 765 plotter. PSAP serves as a preprocessor for SAP IV models, and serves as a postprocessor for displacements of those models. Unfortunately, PSAP is severely limited in the type of elements it can plot.

2. Motivation for SUBROUTINE PSAP1

With the introduction of the ADINA [reference 2] program at NPS in January, 1977, and with expectation of

doing future analysis on ceramic turbine blades, it was desired to expand PSAP to include all ADINA elements and the 8-20 node brick elements in SAP IV. Like PSAP, PSAP1 contains preprocessing and displacement postprocessing capabilities. PSAP1 is presented in this thesis and has the following improvements over PSAP:

a. Preprocessing for all ADINA elements.

b. SAP IV 8 and 8-20 node elements.

c. Expansion of SUBROUTINE ERROR.

d. Interpolation of curves using shape functions [reference 3] through three points on the edges of the 8-20 node brick elements and the 4-8 node plane elements.

e. Improvements in defining the plot origin.

f. Addition of an option (ISCALE = 0) to plot sections of a model without losing perspective.

g. Several other minor modifications considered improvements.

C. PRESENT CAPABILITY

PSAP1 has the capability to plot all ADINA elements and all SAP IV elements except the pipe element. It will interpolate curves on the edges of 4-8 node plane elements and 8-20 node brick elements. Many options are given in Appendix A. Some of the more frequently used options are listed below:

1. Numbering of grid points (NOTAT = 1).
2. Numbering of the elements (NOTAT = 2).
3. Exploded plot (KDISP = 2).

4. Postprocessing of displacements (NUDISP or NVDISP or NWDISP = 1) in two forms: plot of deformed structure (KDISP = 1) or displacements represented by vectors at the nodes (KDISP = 3; see reference 6).

5. Symmetric representation about the XY (KSYMXY = 1), XZ (KSYMXZ = 1) or YZ(KSYMYZ = 1) planes.

6. Option to plot sections of the model (partial plot) to obtain a better view. Partial plots may be plotted to the scale of the complete model to avoid losing perspective (ISCALE = 0) or blown up to obtain a better view (ISCALE = 1). Multiple plots may be obtained using the same geometry and same displacement data (KODE = 1), same geometry and new displacement data (KODE = 2), or new geometry and new displacement data (KODE = 3; see figure 1).

In general, multiple plots (sections, partial plots, additional problems) present no problem. Plotting package user courtesy dictates that no more than 5 plots be placed on the CALCOMP plotter at any one time. Also, if the plots contain many elements (especially 8-20 node elements), it is possible to run out of space in the plotting data sets. When this happens, you will receive

ERROR IHC240I STAE, ABEND CODE IS: SYSTEM OB37 SYSPLOT.

The best thing to do is split the run into two jobs. If the job must be run on one job (i.e., a large number of elements in the model or an assembly drawing where the scale of multiple plots is the same), then SYSPLOT space

may be increased [references 7 and 8] by adding the card

```
//GO.SYSPLOT DD SPACE=(CYL,(needed space)),SYSOUT=C
```

just prior to card

```
//GO.FT10F001 DD UNIT = SYSDA
```

in Appendix A. It would be wise to seek advice from a consultant in Ingersoll 146 if additional plotting space is required.

D. EASE OF MODIFICATION

Both PSAP and PSAP1 are written to maintain as much generality as possible for ease of expansion and modification. Several FORTRAN statements, variables and subroutines are not used. They were left purposely unchanged. Although PSAP1 specifically reads ADINA and SAP IV data, it can easily be expanded to include any geometry and element data format. Simply study the read-in and storage methods (see Section II), and construct appropriate subroutines to read any particular format.

II. PROGRAM ORGANIZATION AND DESCRIPTION OF OPERATION

A. PSAP1 FLOW CHART

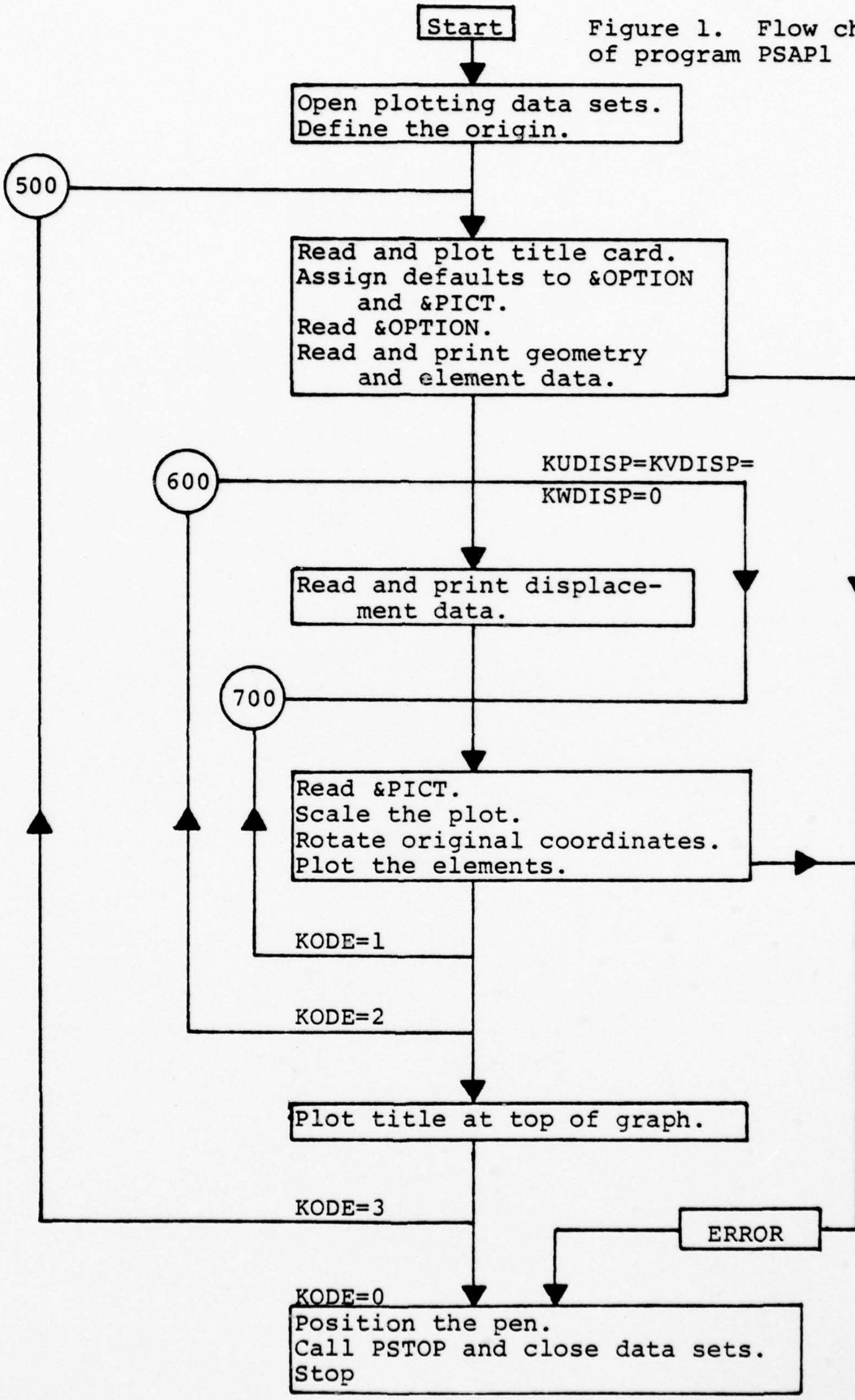
Figure 1 is a condensed flow chart of PSAP1. Probably the most important information given on this chart is the sequence in which the data cards, NAMELIST OPTION and NAMELIST PICT are read. Remember, when generating a sequence of plots, once a parameter has been defined, it retains that value until it is reassigned. Note that when KODE = 1 or 2, the original values of NAMELIST OPTION and NAMELIST PICT are retained until they are changed. However, when KODE = 3 a new title card, NAMELIST OPTION and a set of problem data are read. All variables in NAMELIST OPTION and NAMELIST PICT are assigned their default values. A new problem begins in this case. It is important that the last NAMELIST PICT to be read must contain the value of KODE = 0.

B. NAMELISTS AND EULER ANGLES

1. NAMELIST OPTION

Description and default values of NAMELIST OPTION are given in Appendix A. Basically NAMELIST OPTION variables pertain to the given problem: the number of nodes, geometry format, displacement format, space between plots, and paper size. Default values for NAMELIST OPTION are set, and NAMELIST OPTION is read at the beginning of the problem. Assigned values will remain until exit from the

Figure 1. Flow chart of program PSAP1



program (KODE = 0) or a new set of problem data is read (KODE = 3).

2. NAMELIST PICT

Like NAMELIST OPTION, NAMELIST PICT variable descriptions and default values are given in Appendix A. Basically NAMELIST PICT variables pertain to a given plot. One NAMELIST OPTION may apply to several successive plots, but each NAMELIST PICT defines a unique plot. That plot may include the whole model, part of the model and any options defined in NAMELIST PICT. NAMELIST PICT also specifies the viewing plane through the Euler angles (figure 18, Appendix A).

a. Oblique Orthographic Projections (Euler Angles)

An example of an oblique orthographic projection of a finite element model is given in figure 18 in Appendix A. The model can be viewed in any selected orientation. Euler angle transformations are used to specify orientation of the model to be projected. As described in reference 4, this transformation resolves the coordinate system of the model to a principal viewing plane (i.e., X_oY_o, X_oZ_o, Y_oZ_o) on which the display is to be plotted. Prior to rotation, the model coordinate system (X,Y,Z) is coincident with the coordinate system containing the viewing planes (X_o,Y_o,Z_o). The viewing planes are fixed, and the model is rotated about its model coordinate system. The rotations (ψ,θ,ϕ) of the body about the model axes (X,Y,Z) are shown in figure 18, Appendix A. The NAMELIST PICT variables KHORZ (horizontal

axis), KVERT (vertical axis), PSI (ψ), THETA (θ), and PHI (ϕ) specify the viewing plane and Euler angles. The order of the Euler angle rotations must be PSI, THETA and then PHI. Mathematical transformations are:

$$\begin{Bmatrix} X_o \\ Y_o \\ Z_o \end{Bmatrix} = [\underline{A}_\phi]\ [\underline{A}_\theta]\ [\underline{A}_\psi] \begin{Bmatrix} X \\ Y \\ Z \end{Bmatrix}$$

$$[\underline{A}_\psi] = \begin{bmatrix} \text{Cos}\,\psi & -\text{Sin}\,\psi & 0 \\ \text{Sin}\,\psi & \text{Cos}\,\psi & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$[\underline{A}_\theta] = \begin{bmatrix} \text{Cos}\,\theta & 0 & \text{Sin}\,\theta \\ 0 & 1 & 0 \\ -\text{Sin}\,\theta & 0 & \text{Cos}\,\theta \end{bmatrix}$$

$$[\underline{A}_\phi] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \text{Cos}\,\phi & -\text{Sin}\,\phi \\ 0 & \text{Sin}\,\phi & \text{Cos}\,\phi \end{bmatrix}$$

SUBROUTINE ROTAT calculates the transformation matrices for every NAMELIST PICT, except if ISCALE = 0. ISCALE = 0 directs the scale of the plot to be the same as that of the

previous plot. Should a rotation occur with ISCALE = 0, the plot width could exceed the paper width.

b. Scaling

The safest scaling method is automatic scaling (ISCALE = 1). The user may specify a scale (ISCALE = 2) and the plot origin (XORGN,YORGN), but one must be careful not to run the plotting pen off the graph paper. ISCALE = 0 is a very useful option. The plot will use the same scale as the previous plot. It is useful in an assembly graph where examination of a mesh in sections without losing perspective is desired. Example 3, Section III, illustrates the option ISCALE = 0. When ISCALE = 1 in a NAMELIST PICT defining a partial plot, a "blow-up" of that section is obtained. <u>ISCALE cannot be zero in the first NAMELIST PICT</u>.

c. Partial Plots

To develop a partial plot, three methods of segregating elements exist: first, by the X, Y, and Z cutting planes; second, by node numbers, and, third, by element numbers. If a model has an area where the elements are relatively small, a "blow-up" may be desired. Choose a numbering scheme or coordinates to define the section to be segregated using one of the methods above. Example 3 (figure 14, Section III) uses X, Y, and Z cutting planes to define the partial plots. Example 4 (figure 17, Section III) uses element numbers to section the plots.

C. NODAL POINT (GEOMETRY) INFORMATION READ-IN

Nodal point data is read in by the GEOMn subroutines (GEOM1, GEOM2, and GEOM9, see figure 2). Since SAP IV and ADINA data decks are similar, SUBROUTINEs GEOM1 and GEOM9 are also very similar. They are both constructed to read and generate data in exactly the same way as ADINA and SAP IV. All data not needed by PSAP1 is disregarded and the nodal point data is stored in array ZZZ (figure 3). After studying storage array ZZZ and GEOM1 (or GEOM9), a user moderately familiar with FORTRAN programming could easily construct a user supplied subroutine (GEOM2) to read the nodal point data in any desired format.

D. ELEMENT (CONNECTIVITY) INFORMATION READ-IN

After reading and storing the nodal point data, the element data must be read. The GEOMn subroutine will read the element control card (NPAR, references 1 and 2). SUBROUTINE ELTYPE (figure 2) calls the proper element subroutine to read the element data specified on the element control card. If several groups of elements are to be read, the process is repeated until all of the element groups have been read. Although the nodal point data is stored in array ZZZ, the element connectivity is read and stored on device 10 (disk).

E. DISPLACEMENT DATA READ-IN FOR DISPLACEMENT POSTPROCESSING

Displacement data may be read in (figure 1) by SUBROUTINE DATA9 (KDATA=9) or SUBROUTINEs DATA1 or DATA5 (user supplied,

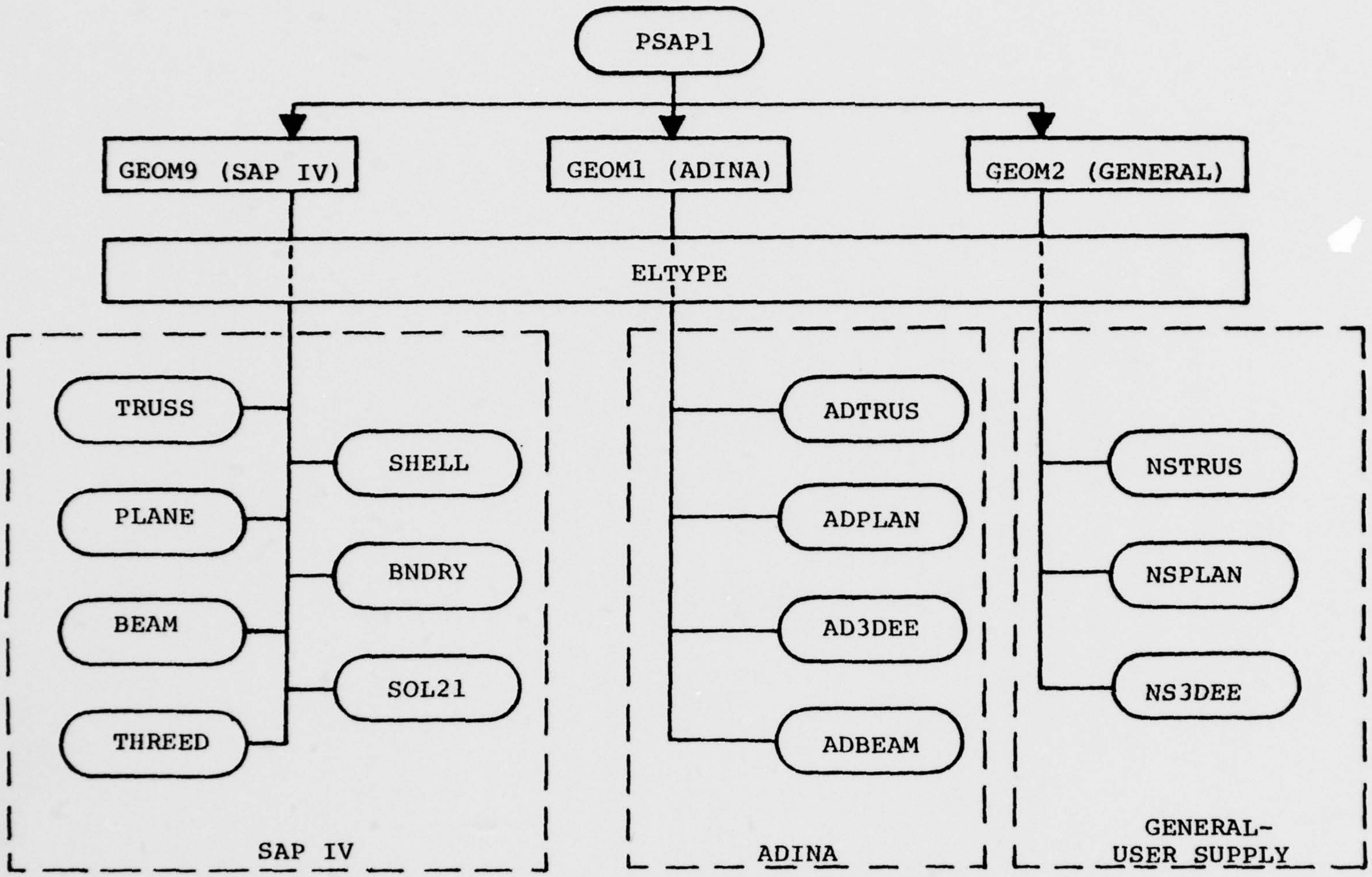


Figure 2. Flow chart for reading geometry and element connectivity data.

$$\begin{bmatrix} ZZZ(1) & ZZZ(N+1) & ZZZ(2N+1) & ZZZ(3N+1) & ZZZ(4N+1) & ZZZ(5N+1) & ZZZ(6N+1) \\ ZZZ(2) & ZZZ(N+2) & ZZZ(2N+2) & ZZZ(3N+2) & ZZZ(4N+2) & ZZZ(5N+2) & ZZZ(6N+2) \\ '' & '' & '' & '' & '' & '' & '' \\ '' & '' & '' & '' & '' & '' & '' \\ ZZZ(N) & ZZZ(2N) & ZZZ(3N) & ZZZ(4N) & ZZZ(5N) & ZZZ(6N) & ZZZ(7N) \end{bmatrix}$$

(a)

$$\begin{bmatrix} NUMPT(1) & XPT(1) & YPT(1) & ZPT(1) & UPT(1) & VPT(1) & WPT(1) \\ NUMPT(2) & XPT(2) & YPT(2) & ZPT(2) & UPT(2) & VPT(2) & WPT(2) \\ '' & '' & '' & '' & '' & '' & '' \\ '' & '' & '' & '' & '' & '' & '' \\ NUMPT(N) & XPT(N) & YPT(N) & ZPT(N) & UPT(N) & VPT(N) & WPT(N) \end{bmatrix}$$

(b)

$$\begin{bmatrix} 1 & X1 & Y1 & Z1 & U1 & V1 & W1 \\ 2 & X2 & Y2 & Z2 & U2 & V2 & W2 \\ '' & '' & '' & '' & '' & '' & '' \\ '' & '' & '' & '' & '' & '' & '' \\ N & XN & YN & ZN & UN & VN & WN \end{bmatrix}$$

(c)

Figure 3. Nodal point and displacement storage arrays. N = The number of nodes. (a) Array in subroutine PSAP1. (b) Arrays in subroutines called by PSAP1. (c) Nodal coordinates and displacements in (a) and (b).

KDATA = 1 or 5). When read, displacement data is stored in the last three columns of array ZZZ (figure 3). PSAP1 can postprocess displacements for both ADINA and SAP IV. The difficulty comes in obtaining a punched deck of cards. Reference 6 gives a description of how to obtain a deck of cards for SAP IV in a format acceptable to SUBROUTINE DATA9. ADINA has no such provision. However, when preprocessing, the displacement data will be omitted (NUDISP=NVDISP=NWDISP=0), and this step will be by-passed.

F. PLOTTING LOGIC

SUBROUTINE PLOTX (figure 4) is the main plotting routine. Since the nodal point data is stored in array ZZZ and the connectivity is stored on device 10, it is a simple matter to read the connectivity from device 10 (one element at a time), and connect the nodes as they are defined in references 1 and 2. For example, NEND = number of nodes defining the connectivity of a single element, NUMEL = the element number and NODE(NEND) is the array containing the connectivity. Device 10 contains this information successively for each element. The statement

```
READ(10) NEND,NUMEL,(NODE(I),I=1,NEND)
```

will read the element connectivity to be plotted. The 8-20 node brick (ADINA and SAP IV) and the 4-8 node plane elements (ADINA) may have 3 points defining each edge. If the midpoint node is defined, then isoparameteric

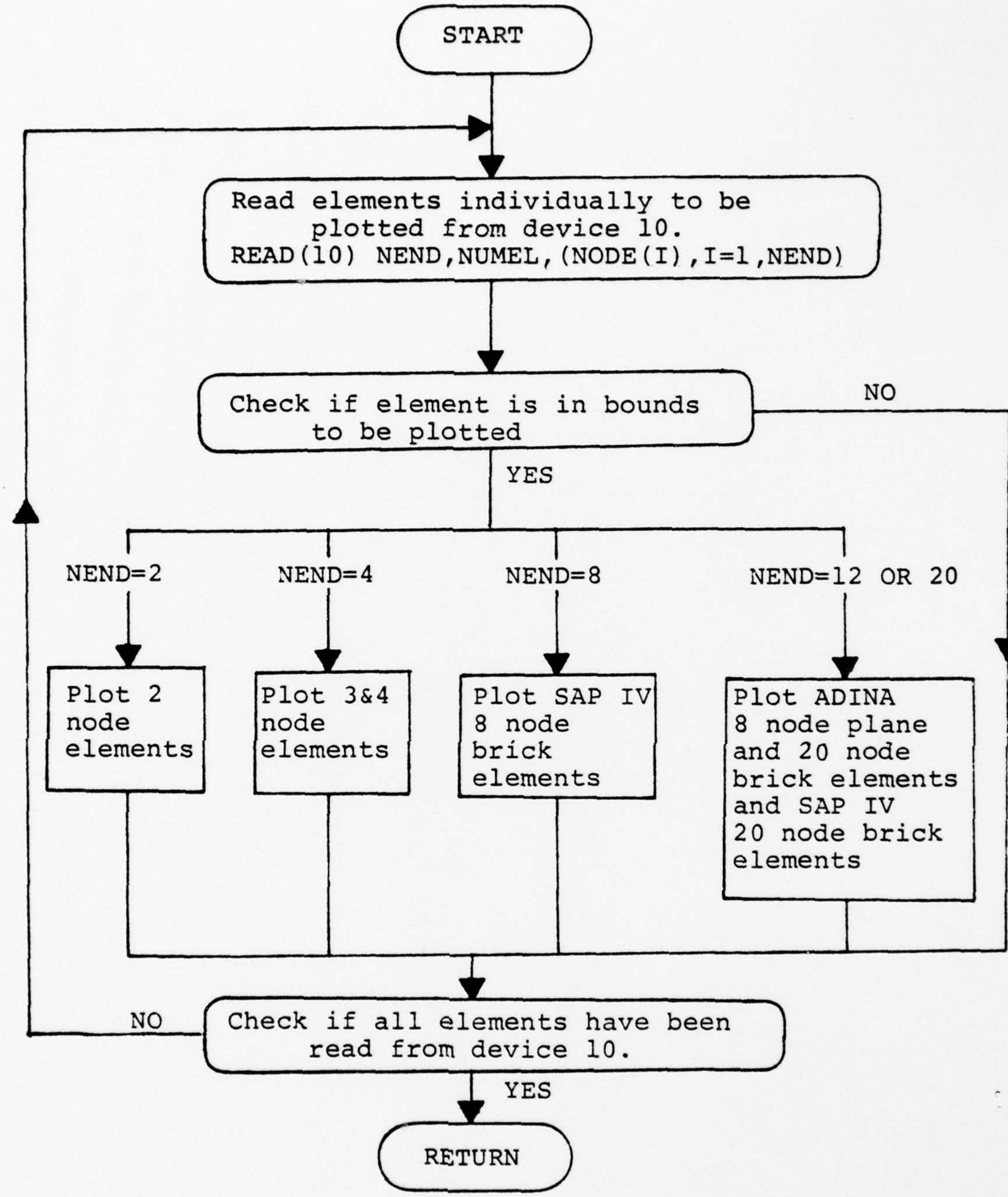


Figure 4. Flow chart for PSAP1 plotting subroutine, PLOTX. Array NODE contains the connectivity of the element being plotted. NEND = the number of nodes defining the connectivity of a single element. NUMEL = the element number.

shape functions (reference 3) are used to interpolate along the three-node edges. These shape functions are identical to those used by ADINA and SAP IV, so the geometry represented graphically is identical to the problem solved in ADINA and SAP IV. SUBROUTINE CURVE does the interpolation with the following equations:

$$X_o = N1 * X_{01} + N2 * X_{02} + N3 * X_{03}$$

$$Y_o = N1 * Y_{01} + N2 * Y_{02} + N3 * Y_{03}$$

$$N1 = S * (S - 1.0) / 2.0$$

$$N2 = - (S + 1.0) * (S - 1.0)$$

$$N3 = S * (S + 1.0) / 2.0$$

$$-1.0 \leq S \leq 1.0$$

PSAP1 uses the NPS plotting package [reference 5] subroutines.

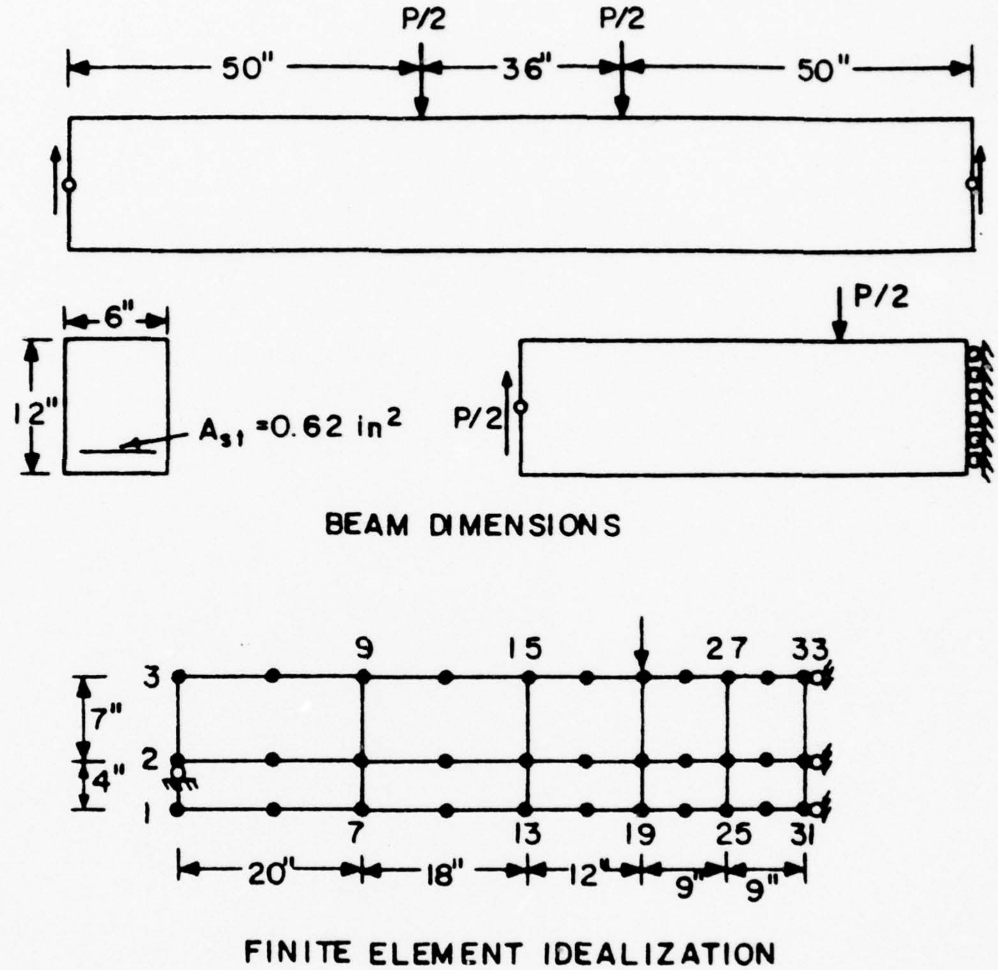
III. PSAP1 SAMPLE PROBLEMS

The following examples have been chosen to illustrate some of the most useful options of PSAP1. Prior to attempting to use PSAP1, the user should have the problem defined and the cards punched in the format of references 1 and 2. Appendix A of this thesis gives a complete description of deck preparation for PSAP1 here at NPS. This section should prove helpful in the understanding and interpretation of the options presented in Appendix A.

A. ADINA EXAMPLES

1. Reinforced Concrete Beam (example 1, figure 5)

This example was chosen because it illustrates the importance of the exploded plot when more than one element group is used. It is taken from the ADINA manual [reference 1]. Figure 6 is a listing of the data cards as they are prepared for ADINA. Figure 7 indicates how that deck would be modified for PSAP1. Note: load cards are removed, NAMELIST OPTION and NAMELIST PICT are added, and the title to be plotted on the graph is added in figure 7. Otherwise, figures 6 and 7 are the same. Figure 8, part (a), illustrates an undistorted (KDISP = 0) PSAP1 plot with the nodes numbered (NOTAT = 1). Figure 8, part (b), shows the same mesh in an exploded form (KDISP = 2) with the elements numbered (NOTAT = 2). Note how the truss elements are visible in the exploded plot.



MATERIAL PROPERTIES:

σ_c = 3740 psi

σ_t = 458 psi

$\sigma_{y\,steel}$ = 44000 psi

$E_{o_{concrete}}$ = 6100 ksi

ν = 0.2

E_{steel} = 30000 ksi

$E_{t_{steel}}$ = 300 ksi

Figure 5. Example 1, ADINA truss and 8 node plane elements, Reinforced Concrete Beam (Given on page 84, reference 2).

```
           *****     TITLE CARD ADINA EXAMPLE
NONLINEAR ANALYSIS OF A REINFORCED CONCRETE BEAM

           *****     MASTER CONTROL CARDS
 33100111   0   2   1   2   1.0      0.      1   0
                     BLANK CARD
                     BLANK CARD
            25
                     BLANK CARD
                     BLANK CARD
                     BLANK CARD

           *****     NODAL POINT DATA
  1   1   0   0   1   1   1               0.       0.
  4   1   0   0   1   1   1              10.              3
  7   1   0   0   1   1   1              20.              3
 13   1   0   0   1   1   1              38.              3
 19   1   0   0   1   1   1              50.              3
 25   1   0   0   1   1   1              59.              3
 31   1   1   0   1   1   1              68.
  2   1   0   1   1   1   1               0.      4.      3
  5   1   0   0   1   1   1              10.      4.      3
  8   1   0   0   1   1   1              20.      4.      3
 14   1   0   0   1   1   1              38.      4.      3
 20   1   0   0   1   1   1              50.      4.      3
 26   1   0   0   1   1   1              59.      4.      3
 32   1   1   0   1   1   1              68.      4.
  3   1   0   0   1   1   1               0.     11.      3
  9   1   0   0   1   1   1              20.     11.      3
 15   1   0   0   1   1   1              38.     11.      3
 21   1   0   0   1   1   1              50.     11.      3
 27   1   0   0   1   1   1              59.     11.      3
 33   1   1   0   1   1   1              68.     11.

           *****     LOAD CONTROL CARD
  1   1  20

           *****     INITIAL CONDITIONS
      1
```

Figure 6. Example 1, ADINA input deck listing, page 1 of 2.

***** Not part of input deck.

```
                    *****    TRUSS ELEMENT INPUT
 1  10   1   0                                                   3   1   3
 1
 0.620   .000733863 0.
30000.     44.0       300.
 1    1    4    1  0.          1   3  0.
 10   28   31   1   0.         1   0  0.
                    *****    2D CONTINUM ELEMENT INPUT
 2  1C   1   0   2     6         3         0         5   1   0   0   0
  1.000217164
 6100.  0.20
0.458   -3.74     -.002      0.0005     0.50
  1    6    1    1    6                  6.
  8    2    1    7    5    0    4    0
  5    6    1    1    6                  6.
 32   26   25   31   29    0   28    0
  6    6    1    1    6                  6.
  9    3    2    8    6    0    5    0
 10    6    1    1    6                  6.
 33   27   26   32   30    0   29    0
                    *****    APPLIED LOAD DATA
 1    9
0.      0.0       1.0       3.2      2.0      4.8      3.0      6.4
 4.0     8.0     5.0      9.5       6.0      11.0     7.0      12.5
8.0      13.5
21   3    1  -0.5
```

Figure 6. Example 1, ADINA input deck listing, page 2 of 2.

***** Not part of input deck.

```
                   *****     PSAP1 TITLE TO BE PLOTTED ON GRAPH
KIBLER AE NONLINEAR ANALYSIS OF A RE-   INFORCED CONCRETE BEAM (ADINA EX)

                   *****     NAMELIST OPTION
 &OPTION
 KGECM=1,
 NNDEST=33,
 YSPACE=10.0,
 &END

                   *****     TITLE CARD ADINA EXAMPLE
NONLINEAR ANALYSIS OF A REINFORCED CONCRETE BEAM

                   *****     MASTER CONTROL CARDS
 33100111    0    2    1    2    1.0        0.        1    0
                             BLANK CARD
                             BLANK CARD
             25
                             BLANK CARD
                             BLANK CARD
                             BLANK CARD

                   *****     NODAL POINT DATA
    1    1    0    0    1    1    1             0.          0.
    4    1    0    0    1    1    1            10.                3
    7    1    0    0    1    1    1            20.                3
   13    1    0    0    1    1    1            38.                3
   19    1    0    0    1    1    1            50.                3
   25    1    0    0    1    1    1            59.                3
   31    1    1    0    1    1    1            68.
    2    1    0    1    1    1    1             0.        4.      3
    5    1    0    0    1    1    1            10.        4.      3
    8    1    0    0    1    1    1            20.        4.      3
   14    1    0    0    1    1    1            38.        4.      3
   20    1    0    0    1    1    1            50.        4.      3
   26    1    0    0    1    1    1            59.        4.      3
   32    1    1    0    1    1    1            68.        4.
    3    1    0    0    1    1    1             0.       11.      3
    9    1    0    0    1    1    1            20.       11.      3
   15    1    0    0    1    1    1            38.       11.      3
   21    1    0    0    1    1    1            50.       11.      3
   27    1    0    0    1    1    1            59.       11.      3
   33    1    1    0    1    1    1            68.       11.

                   *****     LOAD CONTROL CARD
    1    1   20
```

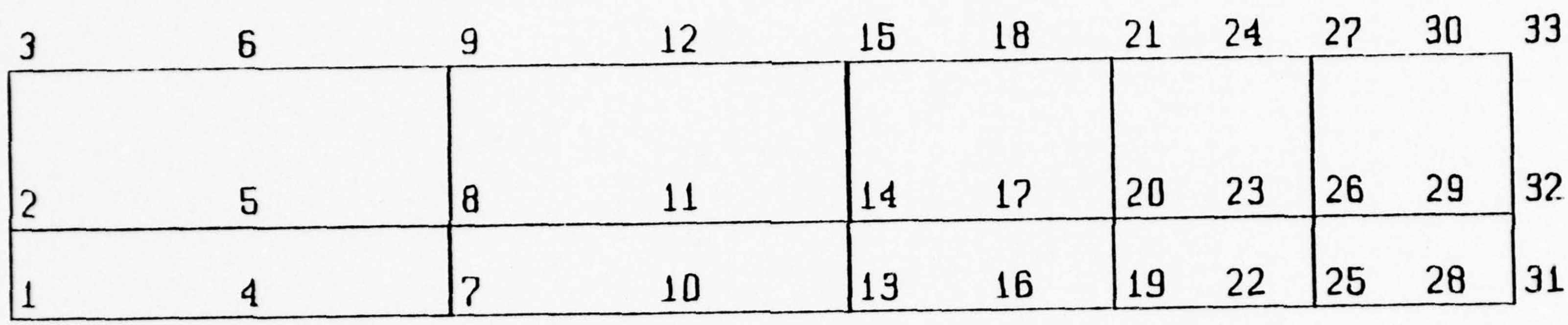
***** Not part of input deck.

Figure 7. Example 1, PSAP1 input deck listing, page 1 of 2.

```
                    *****    INITIAL CONDITIONS
     1
                    *****    TRUSS ELEMENTS
 1  10   1   0                                              3   1   3
 1
0.620   .000733863 0.
30000.    44.0       300.
  1    1    4    1  0.          1    3   0.
 10   28   31    1   0.         1    0  0.
                    *****   2D CONTINUUM ELEMENT INPUT
 2  10   1   0   2        6          3          0          5   1   0   0   0
  1.000217164
 6100.  0.20
0.458   -3.74      -.002      0.0005     0.50
  1    6    1    1    6                  6.
  8    2    1    7    5    0    4    0
  5    6    1    1    6                  6.
 32   26   25   31   29    0   28    0
  6    6    1    1    6                  6.
  9    3    2    8    6    0    5    0
 10    6    1    1    6                  6.
 33   27   26   32   30    0   29    0
                    *****    APPLIED LOAD DATA IS REMOVED
                    *****    NAMELIST PICT (UNDEFORMED STRUCTURE)
&PICT
KHORZ=2,
KVERT=3,
NOTAT=1,
PLOTSZ=8.75,
KODE=1,
&END
                    *****    NAMELIST PICT (EXPLODED PLOT)
&PICT
DMAGS=0.7,
KDISP=2,
KODE=0,
NOTAT=2,
PLOTSZ=9.0,
&END
```

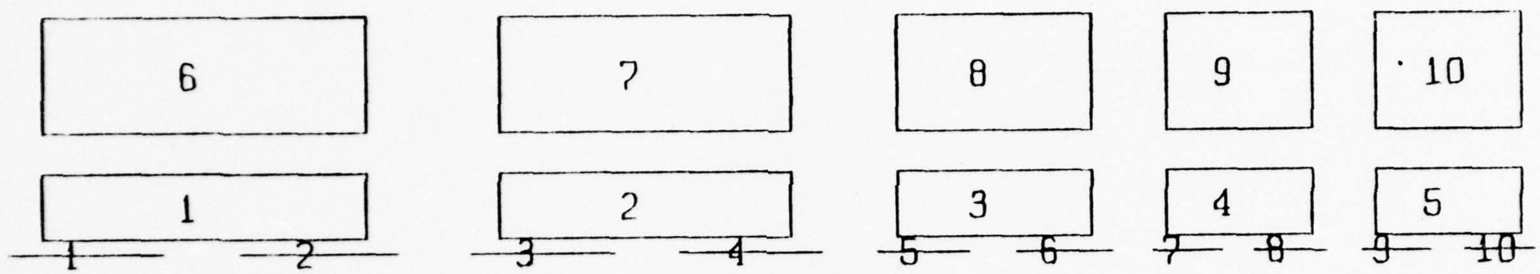
***** Not part of input deck

Figure 7. Example 1, PSAP1 input deck listing, page 2 of 2.



(a) Undeformed structure (KDISP=0), nodes numbered (NOTAT=1).

Figure 8. Example 1, PSAP1 output graphs, page 1 of 2.



(b) Exploded plot (KDISP=2), elements numbered (NOTAT=2).

Figure 8. Continued, page 2 of 2.

2. Flat Plate With Hole (example 2, figure 9)

This is a well known problem with which one can calculate the stress concentration on a hole in a plate under axial tension. Figure 10 is a listing of the PSAP1 deck set-up. The mesh is composed of ADINA variable 4-8 node plane elements. Notice on figure 11, parts (a) and (b), how the interpolating shape functions round off the 3-node edges. Part (a) has the nodes numbered (NOTAT = 1). Part (b) has the elements numbered (NOTAT = 2), and illustrates the use of the symmetry option (KSYMXY=KSYMXZ=1). The symmetry option enables one to obtain a picture of the complete plate even though the model only consisted of a quarter plate with proper boundary conditions.

B. SAP IV EXAMPLES

1. SAP IV Truss Problem (example 3, figure 12)

Figure 13 is a listing of the PSAP1 data deck. Figure 14 indicates how multiple partial plots can be used to obtain a better representation of the model. Part (a) of figure 14 is the complete model. Part (b) is the left half (XXMAX = 50'), and part (c) is the right half (XXMIN = 50', XXMAX = 1.0E20'). Notice also that for Parts (b) and (c), ISCALE = 0, which means succeeding plots have the same scale as the first. Had ISCALE equaled 1 (blow-up), then the width of the half view would have been the same as the complete model. Figure 14 size is limited by the NAMELIST PICT variable PLOTSZ.

Figure 9. Example 2, flat plate with a hole in tension. ADINA 4-8 node plane element.

Thickness = 1 inch

Young's modulus = 30.0×10^6 psi

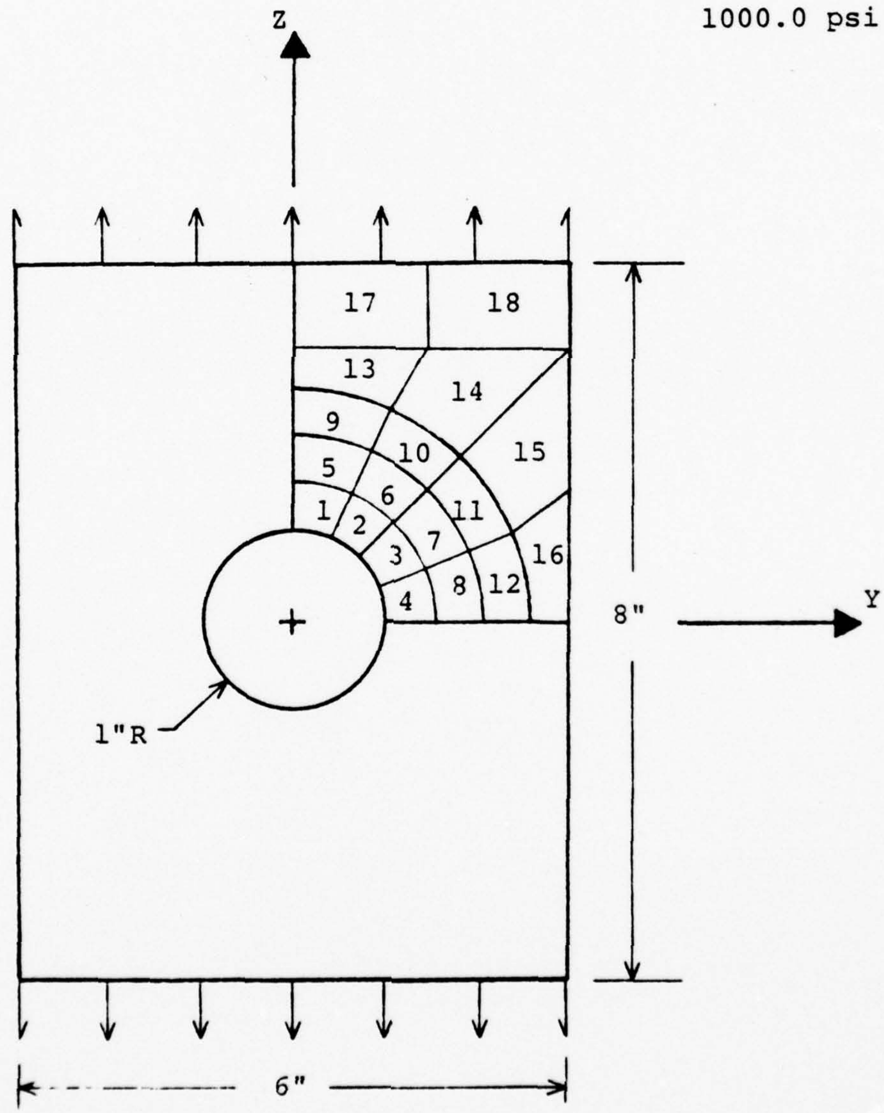
Poisson's ratio = .333

Total elements = 18

Total nodes = 44

Distributed Load =

1000.0 psi



```
                    *****     PSAP1 TITLE CARD TO BE PLOTTED ON GRAPH
KIBLER AE  FLAT PLATE TESTING GEOM1 AND ADPLAN    18 ELEMENTS

                  *****     NAMELIST OPTION
 &OPTION
 KGEOM=1,
 NNDEST=44,
 YSPACE=5.0,
 &END

                  *****     TITLE CARD ADINA EXAMPLE
KIBLER AE  FLAT PLATE PROBLEM IN ADINA 8 NODE PLANE WITH DATA GENERATION

                  *****     MASTER CONTROL CARDS
   44100111    1    0    1    1       1.0        0.0     1     0     0
      0     0    0    0
      0
      0     0    0    0
                            BLANK CARD
            1
                            BLANK CARD

                  *****     NODAL POINT DATA
X    1     1    1    0    1    1    1    0.0        1.0       90.0        9
X   37     1    1    0    1    1    1    0.0        3.0       90.0
X    2     1    0    0    1    1    1    0.0        1.0       78.75       9
X   29     1    0    0    1    1    1    0.0        2.5       78.75
X    3     1    0    0    1    1    1    0.0        1.0       67.50       9
X   30     1    0    0    1    1    1    0.0        2.5       67.50
X    4     1    0    0    1    1    1    0.0        1.0       56.25       9
X   31     1    0    0    1    1    1    0.0        2.5       56.25
X    5     1    0    0    1    1    1    0.0        1.0       45.0        9
X   32     1    0    0    1    1    1    0.0        2.5       45.0
X    6     1    0    0    1    1    1    0.0        1.0       33.75       9
X   33     1    0    0    1    1    1    0.0        2.5       33.75
X    7     1    0    0    1    1    1    0.0        1.0       22.50       9
X   34     1    0    0    1    1    1    0.0        2.5       22.50
X    8     1    0    0    1    1    1    0.0        1.0       11.25       9
X   35     1    0    0    1    1    1    0.0        2.5       11.25
X    9     1    0    1    1    1    1    0.0        1.0        0.0        9
X   36     1    0    1    1    1    1    0.0        2.5        0.0
```

Figure 10. Example 2, PSAP1 input deck listing, page 1 of 3.

***** Not part of input deck.

```
38   1   0   0   1   1   1   0.0        1.5        3.0
39   1   0   0   1   1   1   0.0        3.0        3.0
40   1   0   0   1   1   1   0.0        3.0        1.5
41   1   0   1   1   1   1   0.0        3.0        0.0
42   1   1   0   1   1   1   0.0        0.0        4.0
43   1   0   0   1   1   1   0.0        1.5        4.0
44   1   0   0   1   1   1   0.0        3.0        4.0
                *****     LOAD CONTROL CARD
 3   1   2   0
                *****     INITIAL CONDITIONS
 0   1
                *****     2D CONTINUUM ELEMENT INPUT
 2  18   0   0   2       6          0         0         1   1   0       0   0
 1          0
30.0E06    .333
 1   6   1   1   2                  0        1.0        0
 1   3  12  10   2   0  11
 4   6   1   1                      0        1.0        0
 7   9  18  16   8   0  17
 5   6   1   1   2                  0        1.0        0
10  12  21  19  11   0  20
 8   6   1   1                      0        1.0        0
16  18  27  25  17   0  26
 9   6   1   1   2                  0        1.0        0
19  21  30  28  20   0  29
12   6   1   1                      0        1.0        0
25  27  36  34  26   0  35
13   5   1   1                      0        1.0        0
28  30  38  37  29
14   5   1   1                      0        1.0        0
30  32  39  38  31
15   5   1   1                      0        1.0        0
32  34  40  39  33
16   5   1   1                      0        1.0        0
34  36  41  40  35
17   4   1   1                      0        1.0        0
37  38  43  42
18   4   1   1                      0        1.0        0
38  39  44  43
```

Figure 10. Example 2, PSAP1 input deck listing, page 2 of 3.

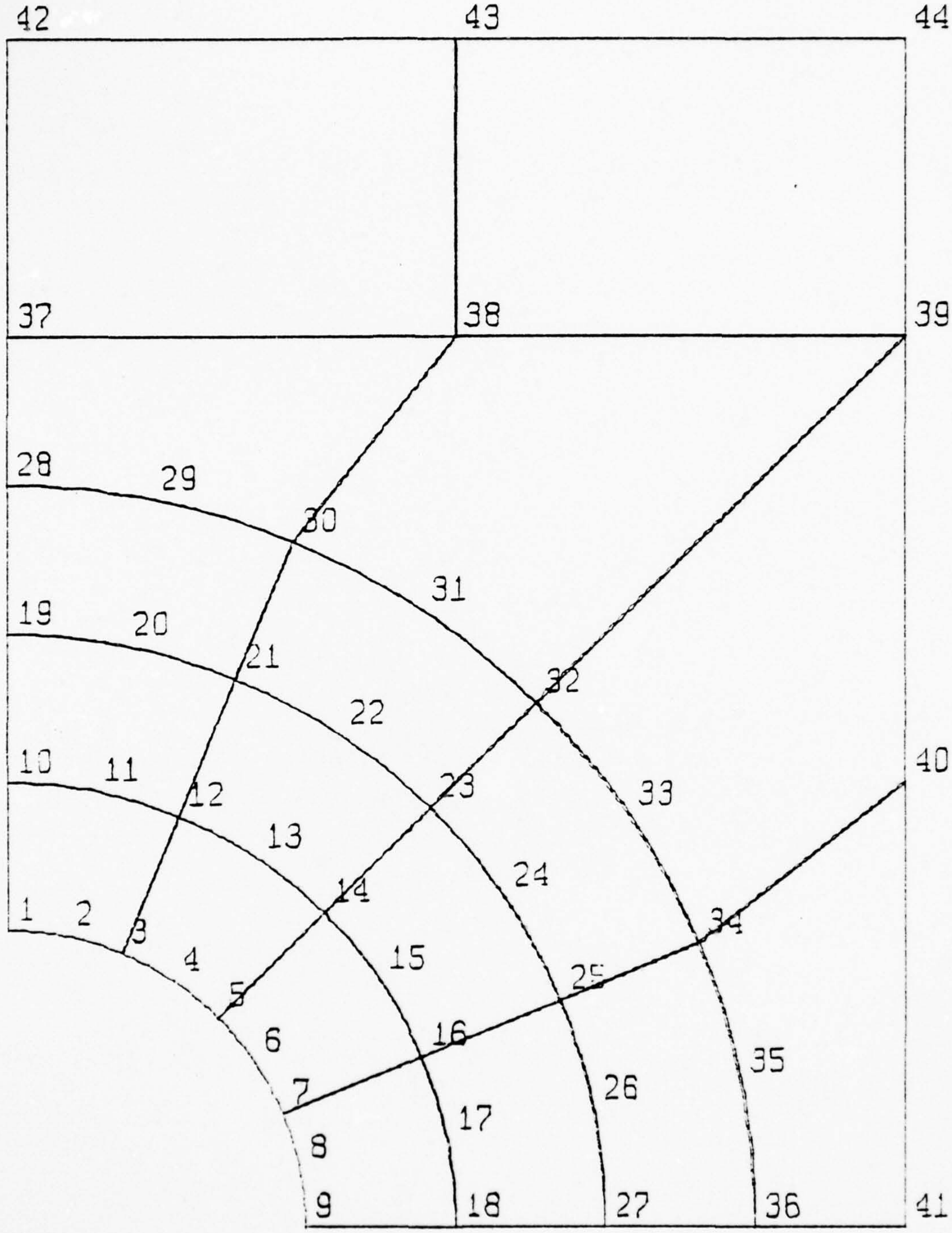
***** Not part of input deck.

```
                    *****     APPLIED LOAD DATA IS REMOVED

                    *****     NAMELIST PICT (ACTUAL STRUCTURE)
&PICT
KHORZ=2,
KVERT=3,
NOTAT=1,
PLOTSZ=7.6,
ISCALE=1,
KODE=2,
&END

                    *****     NAMELIST PICT(SYMMETRIC REPRESENTATION)
&PICT
PLOTSZ=8.0
NOTAT=2,
KSYMXZ=1,
KSYMXY=1,
KODE=0,
&END
```

Figure 10. Example 2, PSAP1 input deck listing, page 3 of 3.

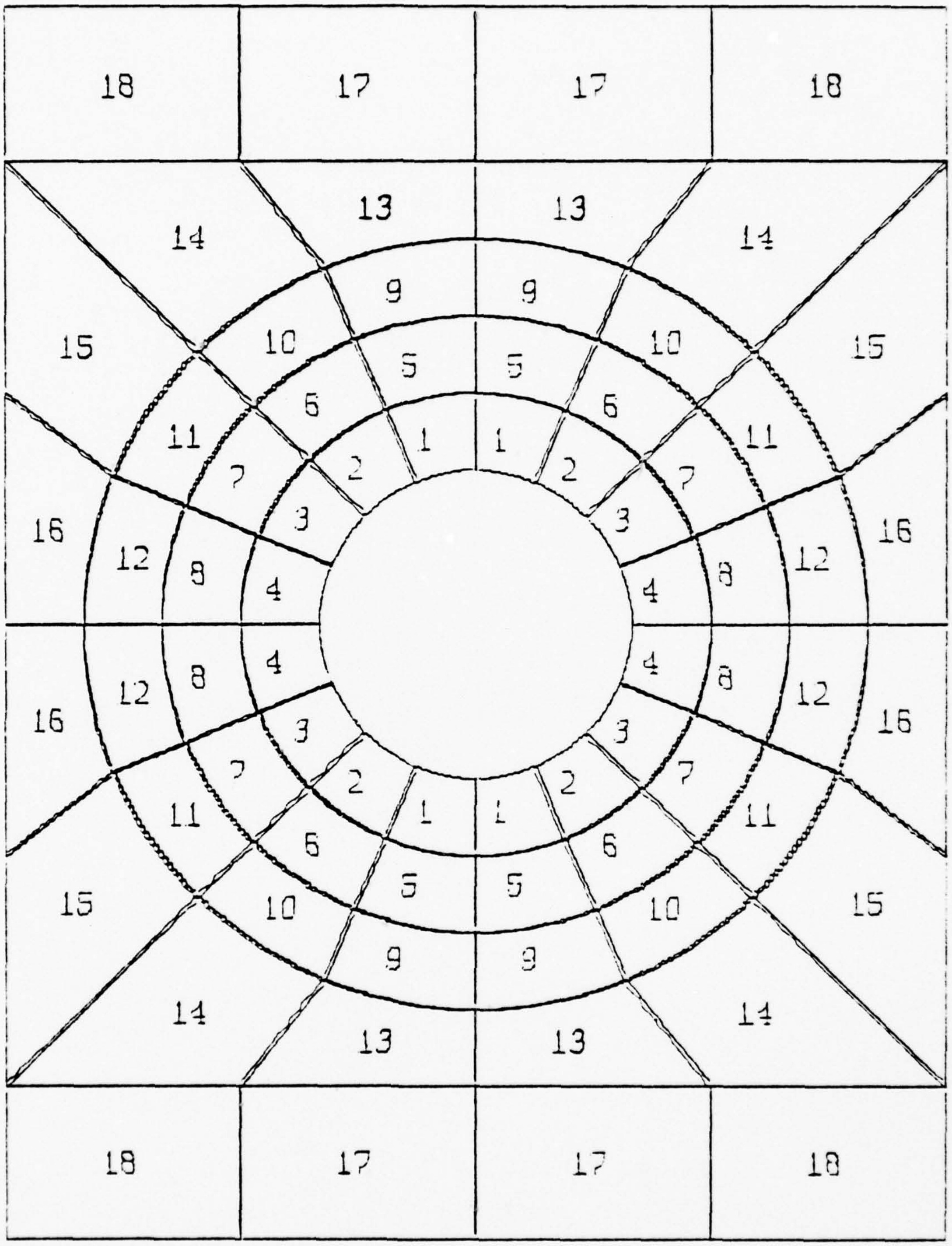
***** Not part of input deck.

Figure 11. Example 2, PSAP1 output graphs, page 1 of 2.



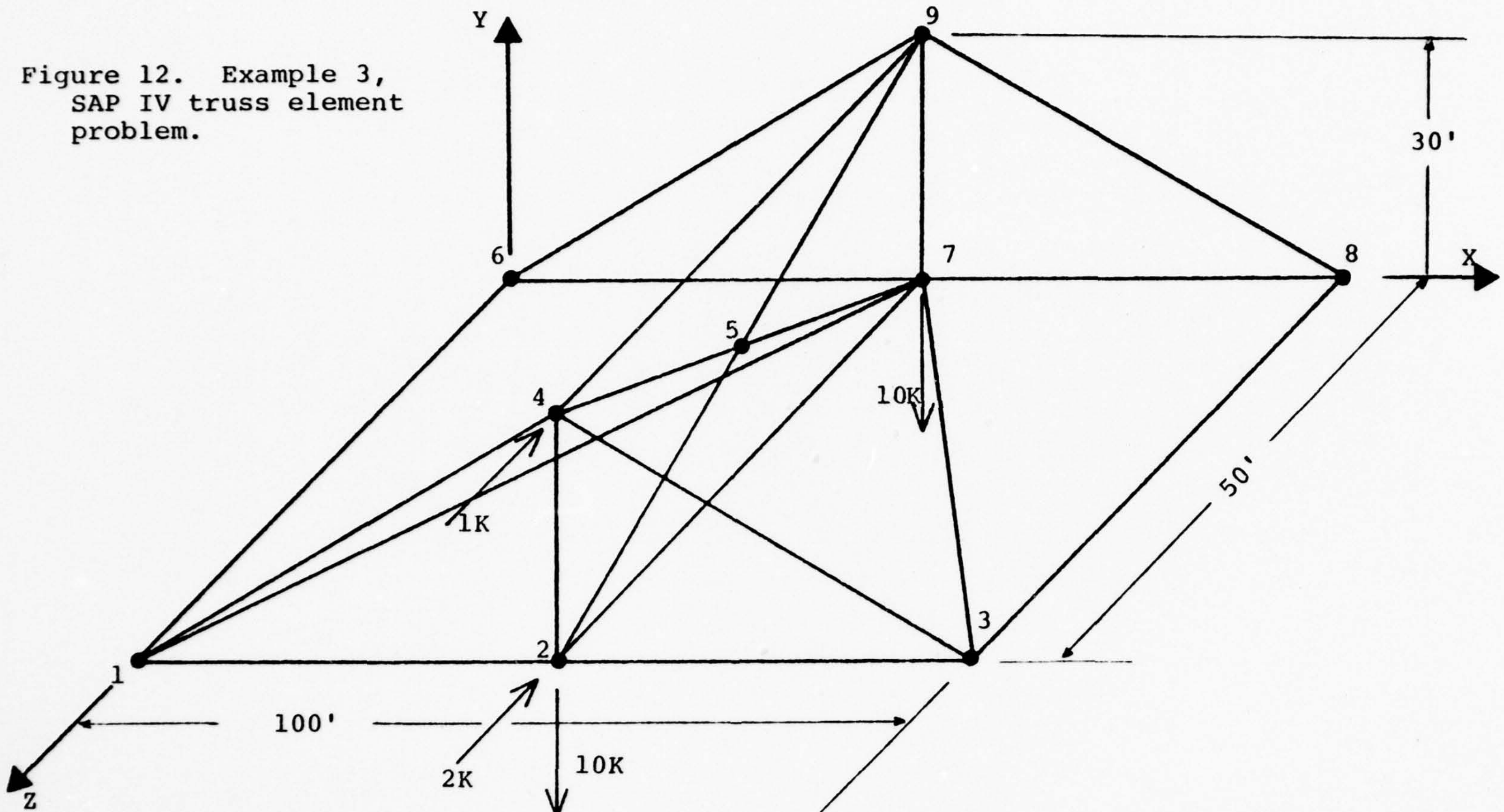
(a) Actual mesh, nodes numbered.

Figure 11. Continued, page 2 of 2.



(b) Symmetric representation, elements numbered.

Figure 12. Example 3, SAP IV truss element problem.



NODE	BOUNDARY CONDITIONS
1	X fixed, Y fixed, Z free
3	X free , Y fixed, Z free
6	X fixed, Y fixed, Z fixed
8	X free , Y fixed, Z fixed
	All others are free.

Young's modulus = 4.32×10^{9} LB/SQFT

Cross-sectional area = 7.0×10^{-2} SQFT

Weight density = 4.89×10^{2} LB/SQFT

```
                    *****     PSAP1 TITLE TO BE PLOTTED ON GRAPH
KIBLER AE   SAP IV TRUSS EXAMPLE PROBLEM
                    *****     NAMELIST OPTION
 &OPTION
 YSPACE=0.25,
 &END
                    *****     TITLE CARD FOR SAP IV EXAMPLE
PSAP SAMPLE TRUSS PROBLEM WITH INNER ELEMENTS
                    *****     MASTER CONTROL CARD
    9    1    1    0    0    0
                    *****     NODAL POINT DATA
    1    1    1    0    1    1    1       0.0        0.0       50.0       70.0
    2    0    0    0    1    1    1      50.0        0.0       50.0       70.0
    3    0    1    0    1    1    1     100.0        0.0       50.0       70.0
    4    0    0    0    1    1    1      50.0       30.0       50.0       70.0
    5    0    0    0    1    1    1      50.0       15.0       25.0       70.0
    6    1    1    1    1    1    1       0.0        0.0        0.0       70.0
    7    0    0    0    1    1    1      50.0        0.0        0.0       70.0
    8    0    1    1    1    1    1     100.0        0.0        0.0       70.0
    9    0    0    0    1    1    1      50.0       30.0        0.0       70.0
                    *****     THREE DIMENSIONAL TRUSS ELEMENT DATA
    1   20    1
    1   4.32E09   6.5E-06         0   7.0E-02   4.89E02


    1    1    2    1        70.0
    2    2    3    1        70.0
    3    1    4    1        70.0
    4    2    4    1        70.0
    5    3    4    1        70.0
    6    1    6    1        70.0
    7    1    7    1        70.0
    8    2    7    1        70.0
    9    3    7    1        70.0
```

Figure 13. Example 3, PSAP1 input deck 1 listing, page 1 of 2.

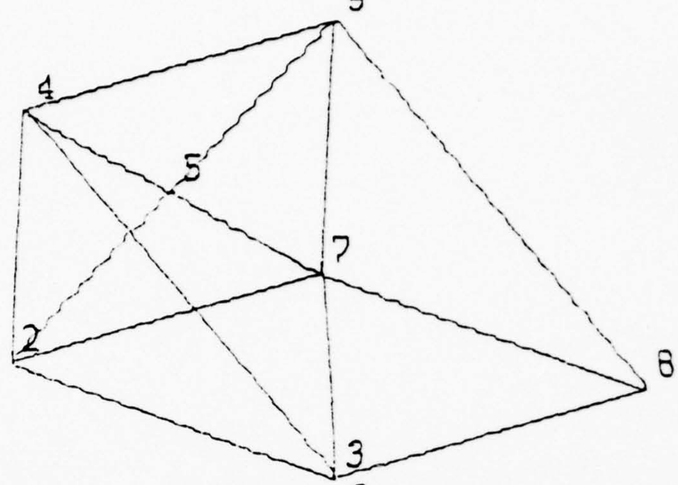
***** Not part of input deck.

```
10     3     8     1          70.0
11     2     5     1          70.0
12     4     5     1          70.0
13     4     9     1          70.0
14     5     7     1          70.0
15     5     9     1          70.0
16     6     7     1          70.0
17     7     8     1          70.0
18     6     9     1          70.0
19     7     9     1          70.0
20     8     9     1          70.0
                         *****      LOAD,LOAD CASE MULTIPLIER AND DYNAMIC ANALYSIS
                         *****      CARDS REMOVED

                         *****      NAMELIST PICT FOR TOTAL MESH
&PICT
KHORZ=1,
KVERT=2,
PSI=-20.0,
PHI=25.0,
THETA=-40.0,
PLOTSZ=4.5,
NOTAT=1
KODE=1,
&END
                         *****      NAMELIST PICT (LEFT HAND SIDE)
&PICT
XXMAX=50.0,
ISCALE=0,
&END
                         *****      NAMELIST PICT (RIGHT HAND SIDE)
&PICT
XXMAX=1.0E20,
XXMIN=50.0,
KODE=0,
&END
```

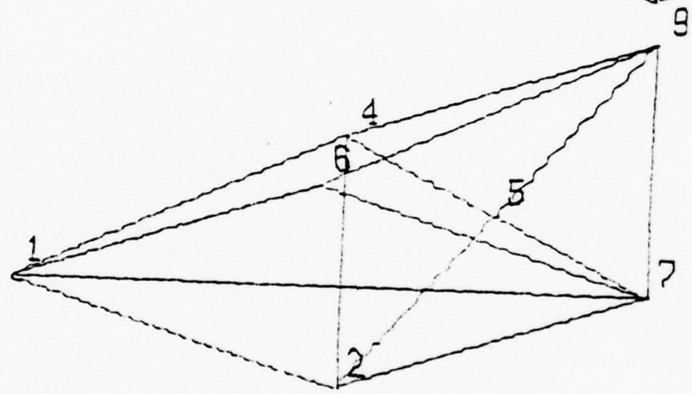
Figure 13. Example 3, PSAP1 input deck listing, page 2 of 2.

***** Not part of input deck.

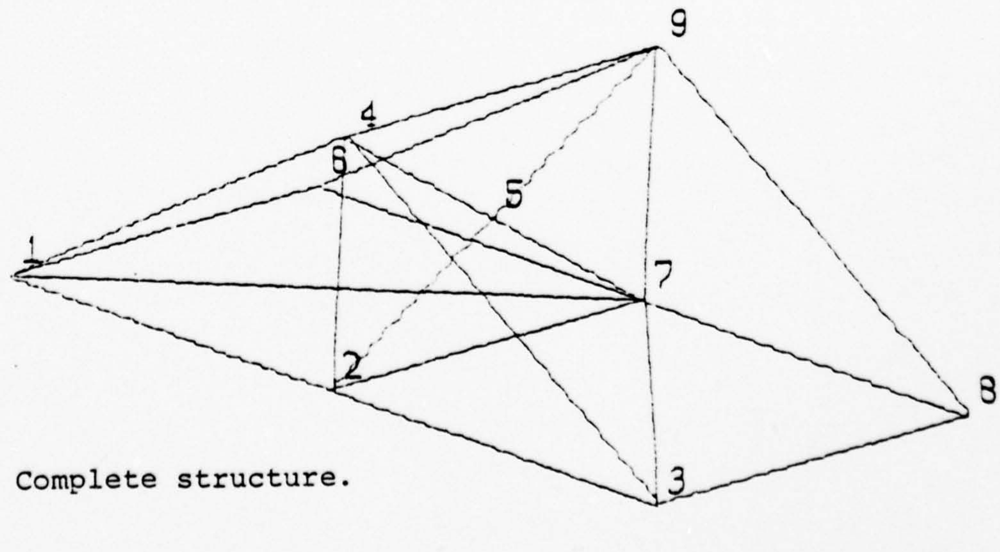
Figure 14. Example 3, PSAP1 output graphs.



(c) Right hand side.



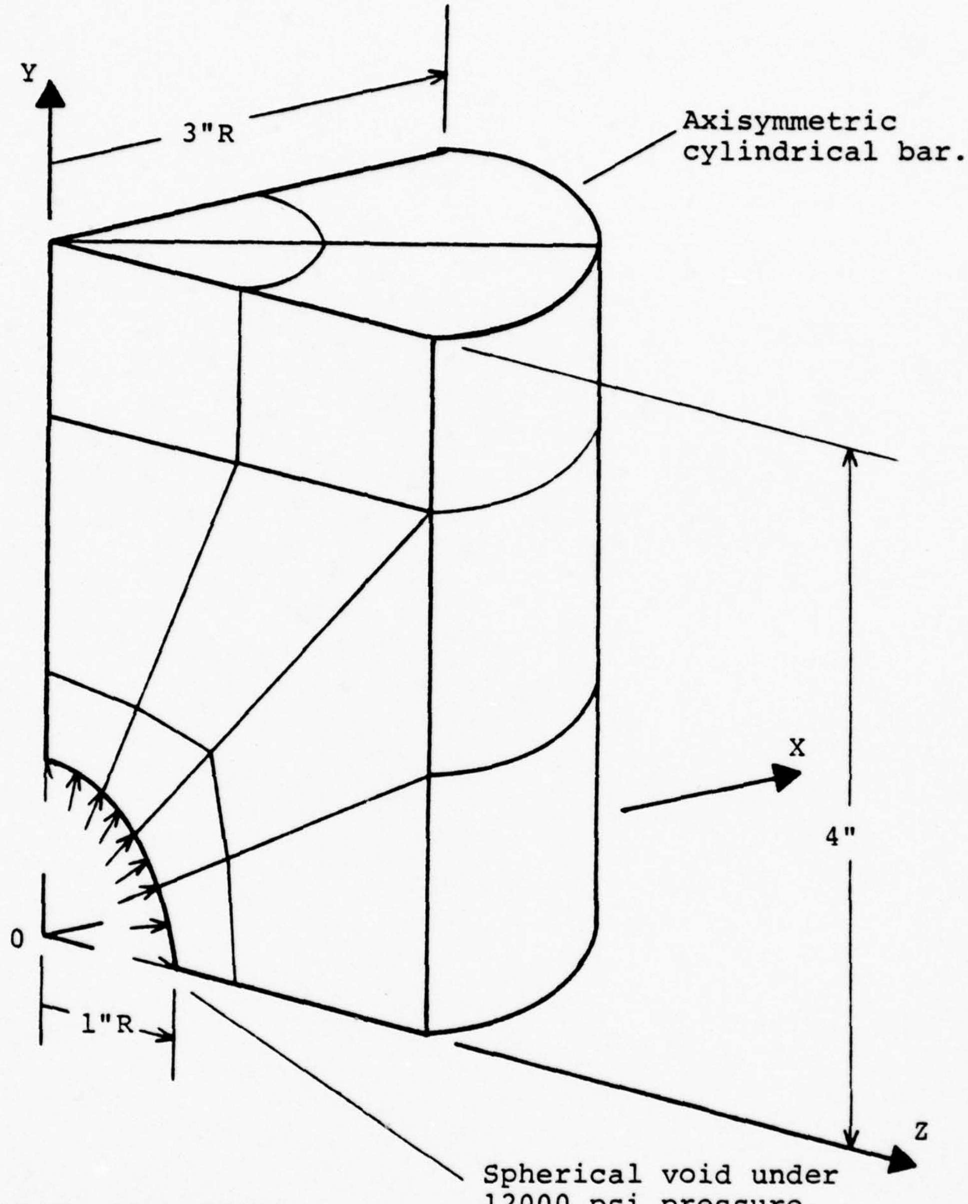
(b) Left hand side.



(a) Complete structure.

2. Cylindrical Bar With Spherical Hole (example 4, figure 15)

This mesh could have several uses. Two might be to calculate stress concentrations if the bar is under axial load or to calculate loading if the void is under pressure (i.e., dispersed nuclear fuel pellet). Figure 16 is a listing of the PSAP1 data deck. Figure 17, part (a), is a representation of the complete model. Parts (b), (c), (d), and (e) of figure 17 are partial plots of the total structure using options of the undeformed structure (KDISP = 0) with node numbering (NOTAT = 1), and the exploded plot (KDISP = 2) with element numbering (NOTAT = 2).



BOUNDARY CONDITIONS

X fixed on YZ plane (X = 0)
Y fixed on XZ plane (Y = 0)
Z fixed on XY plane (Z = 0)

Young's modulus = 30.0×10^6 psi

Poisson's ratio = .333

Figure 15. Example 4, six inch diameter cylindrical bar with a two inch diameter spherical void on the center line under pressure.

```
               *****     PSAP1 TITLE TO BE PLOTTED CN GRAPH
KIBLER AE SAP IV 3-D SOLID ELEMENT-21   NODE BRICK TESTING SUBROUTINE SOL21

               *****     NAMELIST CPTION
&OPTICN
YSPACE=6.0,
NNCEST=129,
&ENC
               *****     TITLE CARD FOR SAP IV EXAMPLE
8-20 NCCE BRICK  SPHERICAL VOID WITH PRESSURE - THESIS EXAMPLE

               *****     MASTER CCNTROL CARD
 129    1    1    0    0    0

               *****     NODAL POINT DATA
   1    1    1    0    1    1    1  0.0        0.0        1.0
   2    1    0    0    1    1    1  0.0        0.243      0.970
   3    0    0    0    1    1    1  0.17183    0.17183    0.970
   4    0    1    0    1    1    1  0.243      0.0        0.970
   5    1    0    0    1    1    1  0.0        0.447      0.894
   6    0    0    0    1    1    1  0.17106    0.41297    0.894
   7    0    0    0    1    1    1  0.31608    0.31608    0.894
   8    0    0    0    1    1    1  0.41297    0.17106    0.894
   9    0    1    0    1    1    1  0.447      0.0        0.894
  10    1    0    0    1    1    1  0.0        0.6        0.8
  11    0    0    0    1    1    1  0.42426    0.42426    0.8
  12    0    1    0    1    1    1  0.6        0.0        0.8
  13    1    0    0    1    1    1  0.0        0.707      0.707
  14    0    0    0    1    1    1  0.27056    0.65318    0.707
  15    0    0    0    1    1    1  0.49992    0.49992    0.707
  16    0    0    0    1    1    1  0.65318    0.27056    0.707
  17    0    1    0    1    1    1  0.707      0.0        0.707
  18    1    0    0    1    1    1  0.0        0.8        0.600
  19    0    0    0    1    1    1  0.56568    0.56568    0.600
  20    0    1    0    1    1    1  0.800      0.0        0.600
  21    1    0    0    1    1    1  0.0        0.894      0.447
  22    0    0    0    1    1    1  0.34212    0.82591    0.447
  23    0    0    0    1    1    1  0.63215    0.63215    0.447
  24    0    0    0    1    1    1  0.82595    0.34212    0.447
  25    0    1    0    1    1    1  0.894      0.0        0.447
  26    1    0    0    1    1    1  0.0        0.970      0.243
  27    0    0    0    1    1    1  0.68589    0.68589    0.243
  28    0    1    0    1    1    1  0.970      0.0        0.243
```

Figure 16. Example 4, PSAP1 input deck listing, page 1 of 6.

***** Not part of input deck.

29	1	0	1	1	1	1	0.0	1.0	0.0
30	0	0	1	1	1	1	0.38268	0.92388	0.0
31	0	0	1	1	1	1	0.70711	0.70711	0.0
32	0	0	1	1	1	1	0.92388	0.3827	0.0
33	0	1	1	1	1	1	1.0	0.0	0.0
34	1	1	0	1	1	1	0.0	0.0	1.5
35	1	0	0	1	1	1	0.0	0.359	1.48
36	0	0	0	1	1	1	0.25385	0.25385	1.48
37	0	1	0	1	1	1	0.359	0.0	1.48
38	1	0	0	1	1	1	0.0	0.690	1.45
39	0	0	0	1	1	1	0.26405	0.63748	1.45
40	0	0	0	1	1	1	0.48790	0.48790	1.45
41	0	0	0	1	1	1	0.63748	0.26405	1.45
42	0	1	0	1	1	1	0.690	0.0	1.45
43	1	0	0	1	1	1	0.0	1.01	1.38
44	0	0	0	1	1	1	0.71418	0.71418	1.38
45	0	1	0	1	1	1	1.01	0.0	1.38
46	1	0	0	1	1	1	0.0	1.3	1.3
47	0	0	0	1	1	1	0.49750	1.2010	1.3
48	0	0	0	1	1	1	0.91924	0.91924	1.3
49	0	0	0	1	1	1	1.2010	0.49750	1.3
50	0	1	0	1	1	1	1.30	0.0	1.3
51	1	0	0	1	1	1	0.0	1.38	1.01
52	0	0	0	1	1	1	0.97581	0.97581	1.01
53	0	1	0	1	1	1	1.38	0.0	1.01
54	1	0	0	1	1	1	0.0	1.45	0.690
55	0	0	0	1	1	1	0.55490	1.3396	0.690
56	0	0	0	1	1	1	1.0253	1.0253	0.690
57	0	0	0	1	1	1	1.3396	0.55490	0.690
58	0	1	0	1	1	1	1.45	0.0	0.690
59	1	0	0	1	1	1	0.0	1.48	0.359
60	0	0	0	1	1	1	1.0465	1.0465	0.359
61	0	1	0	1	1	1	1.48	0.0	0.359
62	1	0	1	1	1	1	0.0	1.50	0.0
63	0	0	1	1	1	1	0.57403	1.3858	0.0
64	0	0	1	1	1	1	1.0607	1.0607	0.0
65	0	0	1	1	1	1	1.3858	0.57403	0.0
66	0	1	1	1	1	1	1.5	0.0	0.0
67	1	1	0	1	1	1	0.0	0.0	2.11
68	1	0	0	1	1	1	0.0	1.03	2.11
69	0	0	0	1	1	1	0.72832	0.72832	2.11
70	0	1	0	1	1	1	1.03	0.0	2.11
71	1	0	0	1	1	1	0.0	1.90	1.90
72	0	0	0	1	1	1	1.3435	1.3435	1.90

Figure 16. Continued, page 2 of 6.

***** Not part of input deck.

73	0	1	0	1	1	1	1.90	0.0	1.90
74	1	0	0	1	1	1	0.0	2.11	1.03
75	0	0	0	1	1	1	1.4920	1.4920	1.03
76	0	1	0	1	1	1	2.11	0.0	1.03
77	1	0	1	1	1	1	0.0	2.11	0.0
78	0	0	1	1	1	1	1.4920	1.4920	0.0
79	0	1	1	1	1	1	2.11	0.0	0.0
80	1	1	0	1	1	1	0.0	0.0	3.0
81	1	0	0	1	1	1	0.0	0.75	3.0
82	0	0	0	1	1	1	0.53033	0.53033	3.0
83	0	1	0	1	1	1	0.75	0.0	3.0
84	1	0	0	1	1	1	0.0	1.5	3.0
85	0	0	0	1	1	1	0.57403	1.3858	3.0
86	0	0	0	1	1	1	1.0607	1.0607	3.0
87	0	0	0	1	1	1	1.3858	0.57403	3.0
88	0	1	0	1	1	1	1.5	0.0	3.0
89	1	0	0	1	1	1	0.0	2.25	3.0
90	0	0	0	1	1	1	1.5910	1.5910	3.0
91	0	1	0	1	1	1	2.25	0.0	3.0
92	1	0	0	1	1	1	0.0	3.0	3.0
93	0	0	0	1	1	1	1.1481	2.7716	3.0
94	0	0	0	1	1	1	2.1213	2.1213	3.0
95	0	0	0	1	1	1	2.7716	1.1481	3.0
96	0	1	0	1	1	1	3.0	0.0	3.0
97	1	0	0	1	1	1	0.0	3.0	2.25
98	0	0	0	1	1	1	2.1213	2.1213	2.25
99	0	1	0	1	1	1	3.0	0.0	2.25
100	1	0	0	1	1	1	0.0	3.0	1.50
101	0	0	0	1	1	1	1.1481	2.7716	1.50
102	0	0	0	1	1	1	2.1213	2.1213	1.50
103	0	0	0	1	1	1	2.7716	1.1481	1.50
104	0	1	0	1	1	1	3.0	0.0	1.50
105	1	0	0	1	1	1	0.0	3.0	0.75
106	0	0	0	1	1	1	2.1213	2.1213	0.75
107	0	1	0	1	1	1	3.0	0.0	0.75
108	1	0	1	1	1	1	0.0	3.0	0.0
109	0	0	1	1	1	1	1.1481	2.7716	0.0
110	0	0	1	1	1	1	2.1213	2.1213	0.0
111	0	0	1	1	1	1	2.7716	1.1481	0.0
112	0	1	1	1	1	1	3.0	0.0	0.0
113	1	1	0	1	1	1	0.0	0.0	4.0
114	1	0	0	1	1	1	0.0	0.75	4.0
115	0	0	0	1	1	1	0.53033	0.53033	4.0
116	0	1	0	1	1	1	0.75	0.0	4.0

Figure 16. Continued, page 3 of 6.

***** Not part of input deck.

```
117    1    0    0    1    1    1  0.0       1.50      4.0
118    0    0    0    1    1    1  0.57403   1.3858    4.0
119    0    0    0    1    1    1  1.0607    1.0607    4.0
120    0    0    0    1    1    1  1.3858    0.57403   4.0
121    0    1    0    1    1    1  1.50      0.0       4.0
122    1    0    0    1    1    1  0.0       2.25      4.0
123    0    0    0    1    1    1  1.5910    1.5910    4.0
124    0    1    0    1    1    1  2.25      0.0       4.0
125    1    0    0    1    1    1  0.0       3.0       4.0
126    0    0    0    1    1    1  1.1481    2.7716    4.0
127    0    0    0    1    1    1  2.1213    2.1213    4.0
128    0    0    0    1    1    1  2.7716    1.1481    4.0
129    0    1    0    1    1    1  3.0       0.0       4.0
                *****    VARIABLE NODE THICK SHELL 3D ELEMENTS
  8   20    1                 1   20          3    3
  1
            30.0E06    30.0E06    30.0E06    .333      .333      .333
12.0EC6     12.0E06    12.0E06
  1    6     1
1.20EC4
                              BLANK CARD
                              BLANK CARD
                              BLANK CARD
                              BLANK CARD
      1.0                           1.0
  1   14    0    1    0    0                                  1
 38   34   34   40    5    1    1    7   35        36   39    2         3    6
                              BLANK CARD
  2   16    0    1    0    0                                  1
 46   38   40   48   13    5    7   15   43   39   44   47   10    6   11   14
                              BLANK CARD
  3   16    0    1    0    0                                  1
 54   46   48   56   21   13   15   23   51   47   52   55   18   14   19   22
                              BLANK CARD
  4   16    0    1    0    0                                  1
 62   54   56   64   29   21   23   31   59   55   60   63   26   22   27   30
                              BLANK CARD
  5   18    0    1    0    0
 84   80   80   86   38   34   34   40   81        82   85   35        36   39
 68   67   67   69
  6   20    0    1    0    0
 92   84   86   94   46   38   40   48   89   85   90   93   43   39   44   47
 71   68   69   72
  7   20    0    1    0    0
```

Figure 16. Continued, page 4 of 6. ***** Not part of input deck.

```
 100   92   94  102   54   46   48   56   97   93   98  101    51   47   52   55
  74   71   72   75
   8   20    0    1    0    0
 108  100  102  110   62   54   56   64  105  101  106  109    59   55   60   63
  77   74   75   78
   9   14    0    1    0    0
 117  113  113  119   84   80   80   86  114       115  118    81        82   85
                              BLANK CARD
  10   16    0    1    0    0
 125  117  119  127   92   84   86   94  122  118  123  126    89   85   90   93
                              BLANK CARD
  11   14    0    1    0    0                               1
  40   34   34   42    7    1    1    9   36        37   41     3         4    8
                              BLANK CARD
  12   16    0    1    0    0                               1
  48   40   42   50   15    7    9   17   44   41   45   49    11    8   12   16
                              BLANK CARD
  13   16    0    1    0    0                               1
  56   48   50   58   23   15   17   25   52   49   53   57    19   16   20   24
                              BLANK CARD
  14   16    0    1    0    0                               1
  64   56   58   66   31   23   25   33   60   57   61   65    27   24   28   32
                              BLANK CARD
  15   18    0    1    0    0
  86   80   80   88   40   34   34   42   82        83   87    36        37   41
  69   67   67   70
  16   20    0    1    0    0
  94   86   88   96   48   40   42   50   90   87   91   95    44   41   45   49
  72   69   70   73
  17   20    0    1    0    0
 102   94   96  104   56   48   50   58   98   95   99  103    52   49   53   57
  75   72   73   76
  18   20    0    1    0    0
 110  102  104  112   64   56   58   66  106  103  107  111    60   57   61   65
  78   75   76   79
  19   14    0    1    0    0
 119  113  113  121   86   80   80   88  115       116  120    82        83   87
                              BLANK CARD
  20   16    0    1    0    0
 127  119  121  129   94   86   88   96  123  120  124  128    90   87   91   95
                              BLANK CARD
```

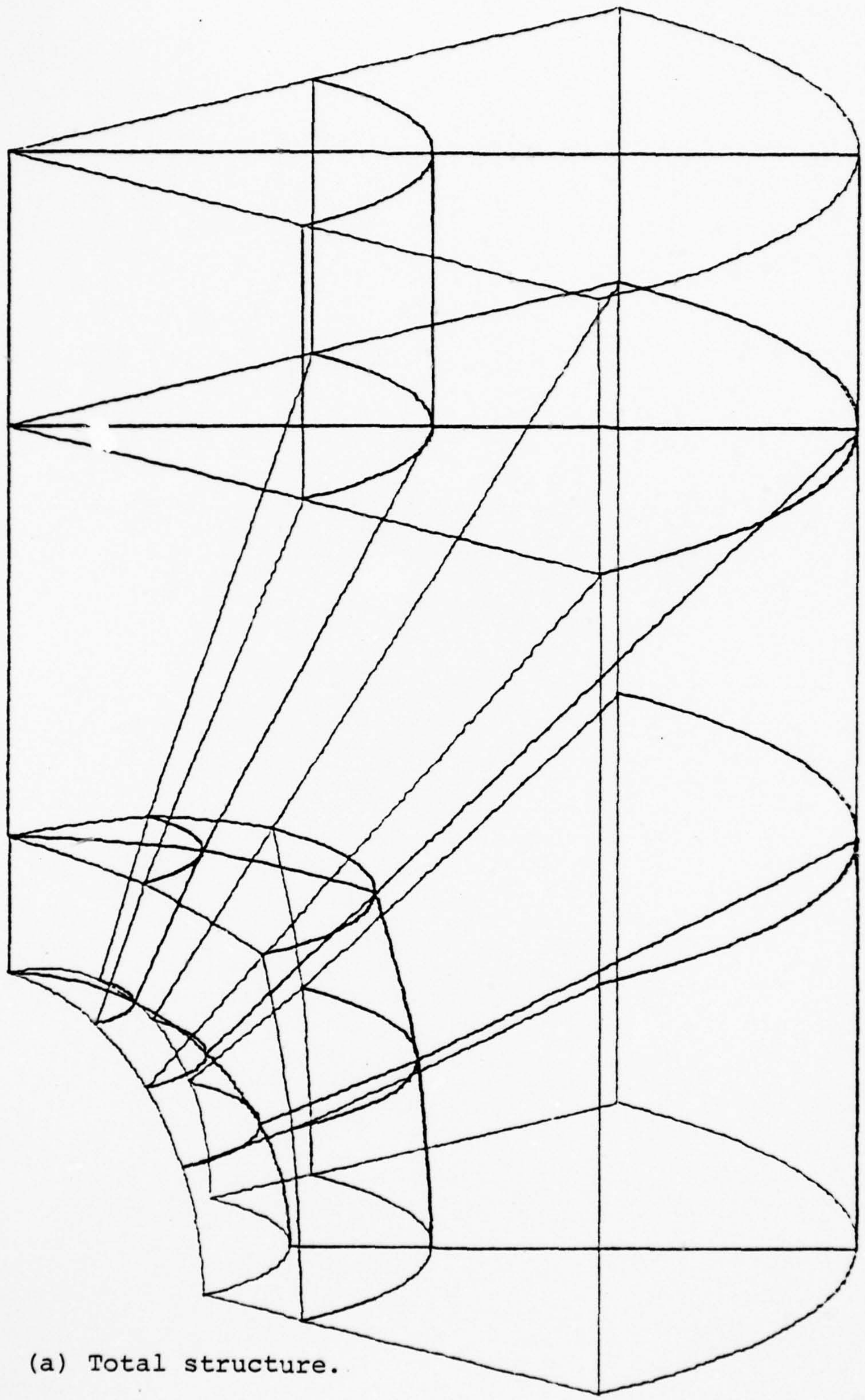
Figure 16. Continued, page 5 of 6. ***** Not part of input deck.

```
                         *****     NAMELIST PICT FOR TCTAL STRUCTURE
&PICT
KHCRZ=2,
KVERT=3,
PHI=10.C,
THETA=1C.0,
PSI=45.0,
ISCALE=2,
XCRGN=C.4,
PSCALE=0.5714,
KOCE=1,
&ENC
                         *****     NAMELIST PICT, ELEMENTS  1-10, NODES NUMBERED
&PICT
ISCALE=C,
NCTAT=1,
XLFT=C.1,
NELMAX=1C,
&ENC
                         *****     NAMELIST PICT, ELEMENTS 1-1C, EXPLODED PLOT
&PICT
NOTAT=2,
KDISP=2,
DMAGS=C.5,
XLFT=0.151,
&ENC
                         *****     NAMELIST PICT, ELEMENTS 11-20, NODES NUMBEREC
&PICT
NOTAT=1,
XLFT=C.1,
KDISP=C,
NELMIN=11,
NELMAX=20,
&ENC
                         *****     NAMELIST PICT, ELEMENTS 11-20, EXPLODED PLOT
&PICT
NOTAT=2,
KDISP=2,
DMAGS=C.5,
XLFT=0.151,
KOCE=0,
&ENC
```

Figure 16. Continued, page 6 of 6.

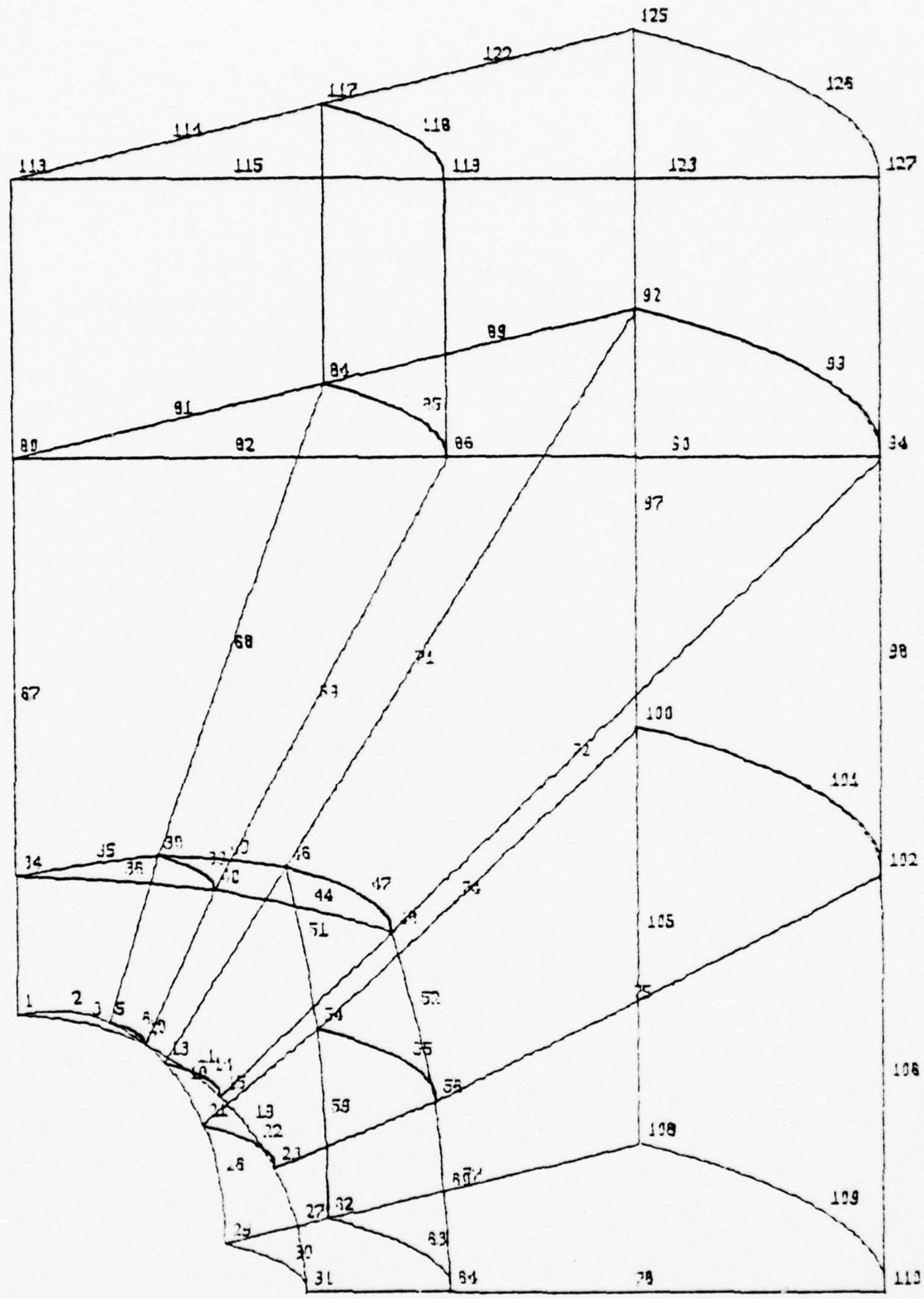
***** Not part of input deck.

Figure 17. Example 4, PSAP1 output graphs, page 1 of 5.



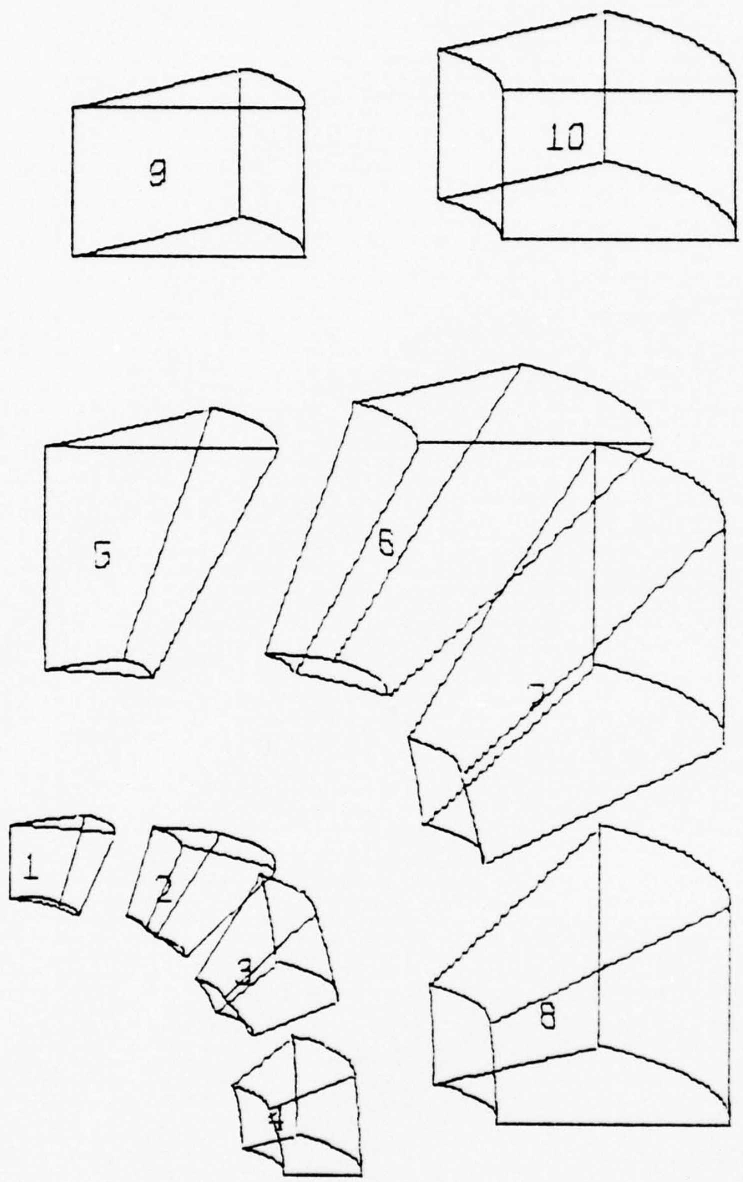
(a) Total structure.

Figure 17. Continued, page 2 of 5.



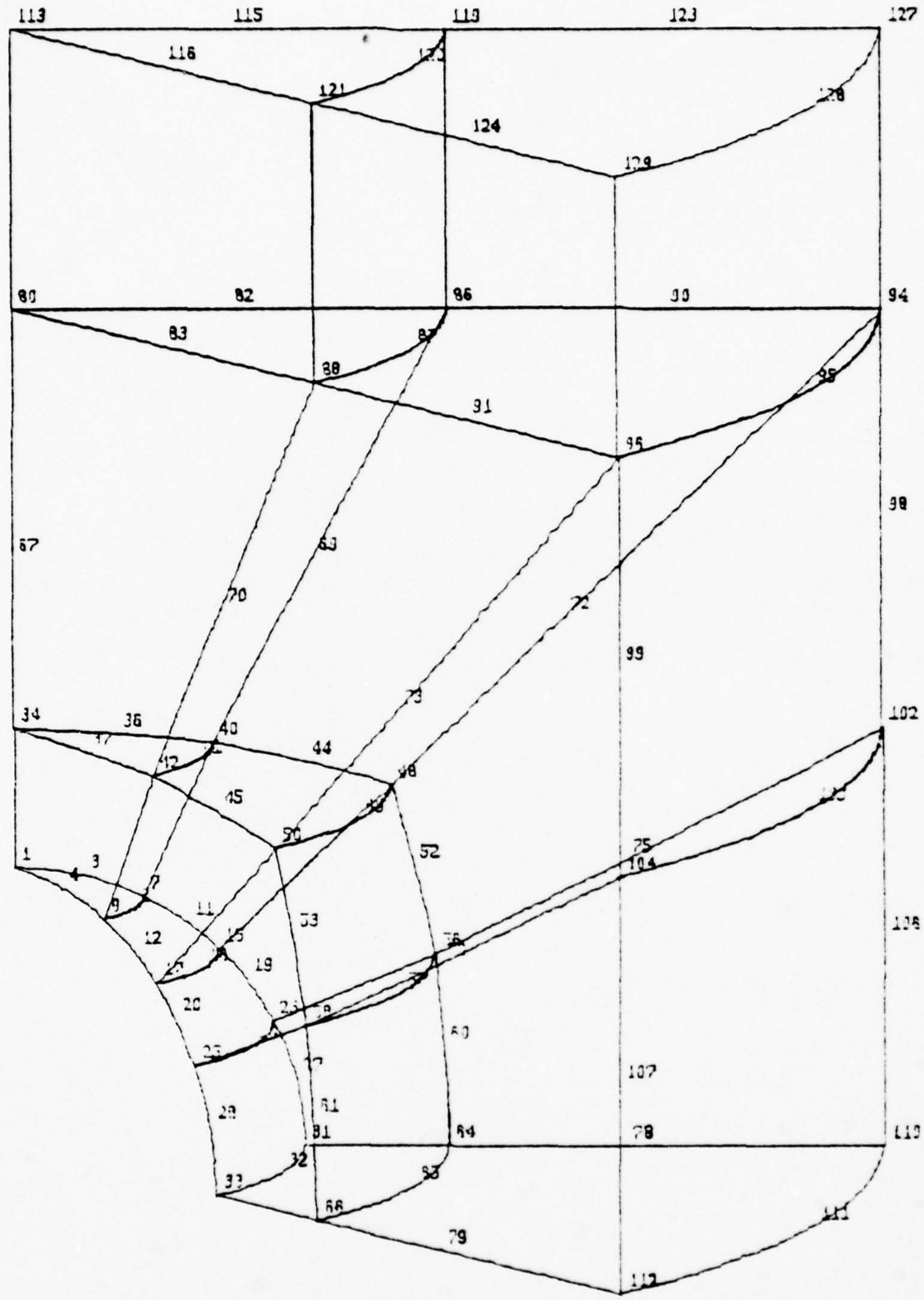
(b) Elements 1-10, nodes numbered.

Figure 17. Continued, page 3 of 5.



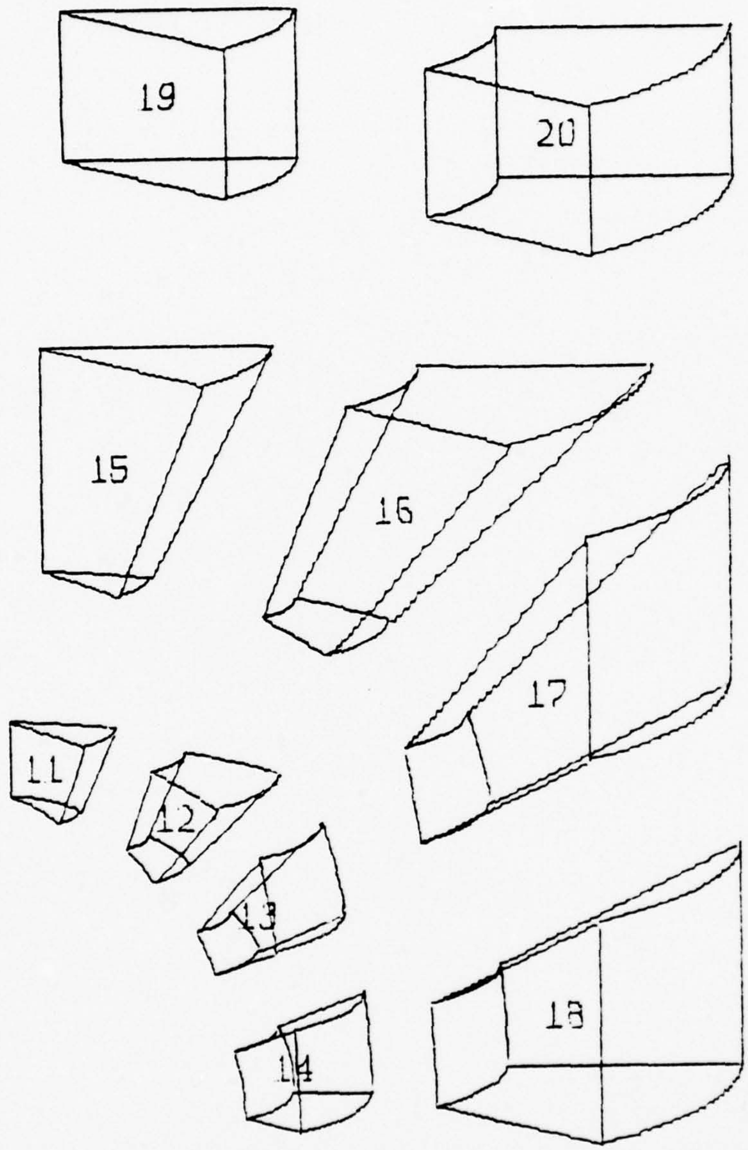
(c) Elements 1-10, elements numbered, exploded plot.

Figure 17. Continued, page 4 of 5.



(d) Elements 11-20, nodes numbered.

Figure 17. Continued, page 5 of 5.



(e) Elements 11-20, elements numbered, exploded plot.

IV. CONCLUSIONS AND RECOMMENDATIONS

With a little study of PSAP1 and figure 2, one realizes how simple it would be to expand PSAP1 to include virtually an unlimited number of geometry data input formats. Simply supply the GEOMn subroutines, element subroutines and modify SUBROUTINE ELTYPE if necessary. Another interesting project would be to incorporate PSAP1 into ADINA and SAP IV so that a mesh plot could be obtained in the data check mode only. Reference 4 contains routines for plotting stress contours which could be incorporated. Hidden line logic is available. It would be difficult but could be incorporated. Hidden line plots are pretty, but they are not very practical when preprocessing because in preprocessing it is advantageous to see all of the nodes.

APPENDIX A

PSAP1 USERS MANUAL

I. NAMELISTS

It may be useful for the user to review NAMELISTs in any good FORTRAN manual. However, a short description of the NAMELIST input is given here. Only columns 2 through 80 of each card will be read. The computer expects to find a special delimiter symbol in column 2 of the first card followed by the NAMELIST name. The delimiter symbol for the IBM 360-370 series is the ampersand & ; other processors use the dollar sign $. Following the first card comes the list of variables and their assigned values. Some important points about the variables are:

A. Variables and their values need not appear in any special order.

B. Predefined variables need not appear in the list if it is not necessary to change the value.

C. A comma should follow each assigned value.

D. It is recommended that each variable appear on a separate card to facilitate change.

The last card following the NAMELIST variables contains, beginning in column 2, the delimiter sign followed by the word END. For example, &OPTION (read NAMELIST OPTION) contains 12 variables. All are initially assigned default

values. But, suppose three of those values (NNDEST=200, KGEOM=9, YSPACE=2.0) do not apply to a specific problem. The &OPTION would be read as follows:

```
_&OPTION
_NNDEST=300,
_KGEOM=1,
_YSPACE=5.0,
_&END
```

Blank space in column 1.

II. INPUT PROCEDURES

The following sequence of cards is necessary to use PSAP1.

```
NOTES  IBM CARDS
       COLUMNS
       123456789--------------

(1)    //  [Standard green job card]
       // EXEC FORTCLGP,REGION.GO=150K
       //FORT.SYSIN DD *

(2)    C     MAIN PROGRAM
             DIMENSION ZZZ(NZ),DISPD(5,3,NON)
             CALL PSAP1(ZZZ,NZ,DISPD,NON)
             STOP
             END

(3)     /*
        //LINK.USDD DD UNIT=3330,VOL=SER=DISK02,
        // DISP=SHR,DSN=S1153.PSAP1
        //LINK.SYSIN DD *
         INCLUDE USDD(LOADM)
         ENTRY MAIN
```

```
(4)      /*
         //GO.FT10F001 DD UNIT=SYSDA,
         // SPACE=(CYL,(3,1)),
         // DCB=(RECFM=VS,BULKSIZE=3520)

(5)      //GO.SYSIN DD *

(6)      [PSAP1 title card as it appears on plot]

(7)      &OPTION
         [&OPTION variables to be initially set or changed]
         &END

(8)      [ADINA or SAP IV geometry data. Title
              card through element data — remove load cards]

(9)      [Case identification card — Omit if IDCASE = 0]
         [Displacement data cards — Omit for preprocessing
                        only]

(10)     &PICT
         [&PICT variables to be initially set or changed]
         &END

(11)     [Additional data as defined by last value of
              KODE in NAMELIST PICT — Omit if last
              value of KODE = 0]

(12)     /*
```

Notes:

(1) Standard basic deck set up as described in chapter 3 of reference 8.

```
// [Standard green job card]
// EXEC FORTCLGP,REGION.GO=150K
//FORT.SYSIN DD *
```

(2) Main program.

```
DIMENSION ZZZ(NZ),DISPD(5,3,NON)
CALL PSAP1(ZZZ,NZ,DISPD,NON)
STOP
END
```

The main program has two functions: to allocate fast storage space, and to call PSAP1. NON must be greater than the number of nodes. NZ must be greater than 4*NON(7*NON if displacement data cards are to be input. i.e., NUDISP, NVDISP, or NWDISP = 1).

(3) Using load module library.

```
/*
//LINK.USDD DD UNIT=3330,VOL=SER=DISK02,
// DISP=SHR,DSN=S1153.PSAP1
//LINK.SYSIN DD *
 INCLUDE USDD(LOADM)
 ENTRY MAIN
```

PSAP1 should be precompiled and stored in the machine in a load module. Load modules are a type of user library described in reference 7 and chapter 3 of reference 8. Since PSAP1 requires over one minute to compile, precompiling results in a large time

savings. These cards are subject to change, and the most current version is determined by the user maintaining this library. If PSAP1 is not on a load module, these control cards may be replaced by subroutine PSAP1 (which consists of a box and a half of cards).

(4) Allocation of storage.

```
/*
//GO.FT10F001 DD UNIT=SYSDA,
// SPACE=(CYL,(3,1)),
// DCB=(RECFM=VS,BULKSIZE=3520)
```

PSAP1 uses a slow storage device to store the element connectivity. These cards allocate 3 cylinders as described in chapter 3 of reference 8.

(5) Deck set up card.

```
//GO.SYSIN DD *
```

This is a standard deck set up card described in chapter 3 of reference 8.

(6) PSAP1 title card.

PSAP1 title card is the title that will appear on the graph. Make sure a user identification is on this card. It consists of 80 alphanumeric characters. The first 40 characters will form the first title line. The last 40 will form the second line.

(7) NAMELIST OPTION.

(Note: start in second column)

```
 &OPTION
[&OPTION variables to be initially set or changed]
 &END
```

VARIABLE-DEFAULT	DESCRIPTION
NNDEST-200	Must be equal to the number of nodes.
NUDISP-0	0 — X direction displacements not input.
	1 — X direction displacements input.
NVDISP-0	0 — Y direction displacements not input.
	1 — Y direction displacements input.
NWDISP-0	0 — Z direction displacements not input.
	1 — Z direction displacements input.

(Note: unless displacement data is to be input, allow NUDISP, NVDISP, and NWDISP to default.)

KGEOM-9 Specifies the geometry input format.

1- Subroutine GEOM1 reads in ADINA data deck geometry and connectivity.

2- Subroutine GEOM2 may be supplied by user along with subroutines NSPLAN, NS3DEE and NSTRUS to read nodal data and connectivity in any format.

9- Subroutine GEOM9 reads in SAP IV data deck geometry and connectivity.

KDATA-9 Specifies the subroutine and corresponding method of input for displacement data.

1- Subroutine DATA1, a user supplied subroutine.

2- Subroutine DATA2, a user supplied subroutine.

9- Subroutine DATA9, reads a punched output displacement deck from execution of SAP IV as presented in reference 6. (Note: unless displacement data is to be plotted, allow to default.)

NVALUS-0 Not incorporated, allow to default.

IRESEQ-1 Not incorporated, allow to default.

KPLOT-1 Not incorporated, allow to default.

YSPACE-2.0 Space between plots in the Y direction in inches when successive plots are plotted (i.e., KODE $\neq$ 0). The graph title is plotted both on the top and at the bottom of each set of graphs controlled by a given NAMELIST OPTION. The space between the title and the plot is YSPACE/2.0.

PSIZE-9.0 Paper size in the X direction, in inches. Used in scaling of the plots to insure this dimension is not exceeded. However, when manual scaling (ISCALE = 2; see NAMELIST PICT) this protection is not available, and it is possible to exceed the paper width.

IDCASE-0 0- No identification card precedes the deck of displacement values.

1- Identification card precedes the deck of displacement values.

(8) SAP IV or ADINA data cards.

Here insert the geometry (node coordinates) and element connectivity. This includes the title card through the element data cards; the load cards are removed. For a SAP IV data deck, NAMELIST OPTION variable KGEOM = 9. For an ADINA data deck, KGEOM = 1.

From ADINA deck remove:

1. Applied loads data.
2. Frequency and mode shape calculations data.

From SAP IV deck remove:

1. Concentrated load mass data.
2. Element load multipliers.
3. Dynamic analysis cards.

Otherwise, these cards are exactly the same as the deck prepared for SAP IV or ADINA. PSAP1 is not limited to SAP IV and ADINA. The user may specify any unique format (i.e., KGEOM = 2). In this case, SUBROUTINE GEOM2 must be supplied by the user.

(9) Case ID card and displacement data cards.

PSAP1 is intended to be used essentially for preprocessing. If it is desired to use the postprocessing option, the user is referred to reference 6. Otherwise, omit the case ID card and displacement data.

(10) and (11) NAMELIST PICT.

(Note: start in second column)

```
 &PICT
[&PICT variables to be initially set or changed]
 &END
```

VARIABLE-DEFAULT	DESCRIPTION
KHORZ-1	Integer designating the horizontal axes of the viewing plane. 1 = X_o. 2 = Y_o. 3 = z_o. (See figure 18.)
KVERT-2	Integer designating the vertical axes of the viewing plane. 1 = X_o. 2 = Y_o. 3 = Z_o. (See figure 18.)
PHI-0.0	Angular rotation of the model about its X axis in degrees (performed 3rd, see figure 18).
THETA-0.0	Angular rotation of the model about its Y axis in degrees (performed 2nd, see figure 18).
PSI-0.0	Angular rotation of the model about its Z axis in degrees (performed 1st, see figure 18).
NEWFR-1	1- Frame change before plotting. 2- No frame change before plotting. (Normally allow to default. A frame change resets the Y origin past the previous plot by YSPACE given in NAMELIST OPTION and resets the X origin at 0.0)
ISCALE-1	0- No scale change. Use the same scale as the previous plot. Useful in an assembly graph where it is desired to examine a mesh in sections

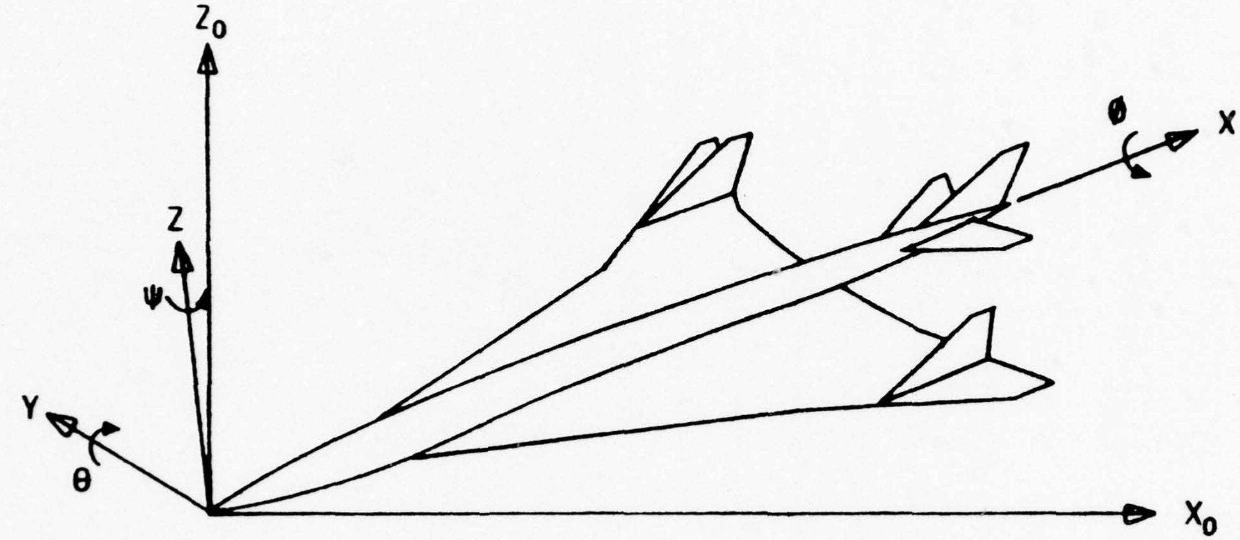


Figure 18. Coordinate systems and Euler angles (rotations) for an oblique orthographic projection shown in X-Z viewing plane. (Taken from reference 4, page 127.)

without losing perspective. See example 3 in Section III of this thesis. ISCALE cannot be zero in the first NAMELIST PICT.

1- Automatic scaling of plot and computation of proper origin location.

2- User specified origin and scaling.

PLOTSZ-10.0 Maximum dimension desired on completed plot prior to rotation. After rotation it is possible for the maximum dimension in the projected plane to exceed PLOTSZ. The maximum size of the projection is unlimited on the vertical axis but is limited by the paper width (PSIZE in NAMELIST OPTION) on the horizontal axis. If rotation of the model causes the projection to go off the paper, it is rescaled prior to plotting. PLOTSZ is used in scaling only if ISCALE = 1).

XORGN-0.0 X location of the plot origin. (Used only if ISCALE = 2.)

YORGN-0.0 Y location of the plot origin. (Used only if ISCALE = 2.)

PSCALE-1.0 Model size reduction factor. PSCALE is equal to the actual model size divided by the desired plot size. It is used only if ISCALE = 2. (Note that when ISCALE = 2 is used, no rescaling occurs if rotation causes the projection to exceed the paper width.)

NOTAT-0 — 0- No numbering on plots.

1- Numbering of grid points.

2- Numbering of elements.

XLHT-0.14 — Height in inches of the integers specified by NOTAT. It should be a multiple of .07. If XLHT is not a multiple of .07, it will be rounded to the nearest multiple. XLHT has a maximum of .49 and a minimum of .07.

KDISP-0 — 0- Plot of undeformed structure.

1- Plot of deformed structure.

2- Exploded plot.

3- Displacement represented by vectors.

KDISP = 1 or 3 represents a form of postprocessing and displacement data must be input in (9). If postprocessing is desired, refer to reference 6.

IDMAG-2 — 1- Direct magnification of displacement data by DMAGS.

2- Scaling of displacement data to a maximum value of DMAGS.

DMAGS-1.0 — Magnification of displacements (if KDISP = 1 or 3). Reduction factor of elements (if KDISP = 2).

KSYMXY-0 — 1- Symmetry about X-Y plane.

KSYMXZ-0 1- Symmetry about X-Z plane.

KSYMYZ-0 1- Symmetry about Y-Z plane.

A plate quadrant with KSYMXZ and KSYMXY equal to 1 would yield a complete plate. See example 2 in Section III in this thesis.

Note: To develop a partial plot, three methods of segregating elements exist: First, by X, Y and Z cutting planes; second, by node numbers; and third, by element numbers. The next ten variables are used to separate elements into partial plots.

XXMAX,YYMAX,ZZMAX-1.0E20 Local cutting planes
XXMIN,YYMIN,ZZMIN-(-1.0E20) Parallel to the principal planes.

NDMAX-9999999 Maximum gridpoint identification number to be included in the plot.

NDMIN-0 Minimum gridpoint identification number to be included in the plot.

NELMAX-9999999 Maximum element number to be included in the plot.

NELMIN-0 Minimum element number to be included in the plot.

KODE-0 Specifies the control option after the plot is completed.

0- Last plot, exit from program.

1- Read another NAMELIST PICT.

2- Read a new set of displacement data. (Postprocessing only.) For KODE = 2, displacement data must be followed by another NAMELIST PICT.

3- Read a complete new set of input data starting with a title card.

For KODE = 1, 2 or 3, additional sections of the deck must be repeated. The deck must end with a NAMELIST PICT having a value of KODE = 0.

Note: A most important point to remember when generating a sequence of plots is that once a parameter has been defined, it retains that value until it is reassigned. For example, if PLOTSZ is assigned a value of 8.0 for the first of a series of plots, and it is not redefined in any subsequent NAMELIST PICT; the value of PLOTSZ will be retained as originally specified. However, when KODE = 3 and a new title, NAMELIST OPTION and problem data are read, all variables in NAMELIST OPTION and NAMELIST PICT are assigned their default values. The

problem starts over in this case. Refer to the flow chart in figure 1 and study the path for different values of KODE.

(12) Delimiter card.

/*

Delimiter card is defined in chapter 3 of reference 8.

III. SPECIAL FEATURES OF PSAP1

A. POSTPROCESSING

Reference 6 contains information and examples on the use of the postprocessor. SAP IV has the capability to punch displacement data cards in an acceptable format for PSAP1 (specifically subroutine DATA9). As of this writing, ADINA does not have this capability, and data cards would have to be punched manually by the user.

B. PARTIAL DATA

Reference 6, on page 30, establishes a procedure by which it is possible to input only a portion of the finite element model for a data check. This feature is valuable in a case where several different people are preparing different parts of a large data base for a problem and desire to check individually their inputs graphically for accuracy. All nodal coordinates for the entire model may be input, or only those that specifically define the portion of the finite element model to be plotted. In either case, all nodal coordinates that define the elements to be plotted must be specified. To use this feature the "element control cards" (described in references 1 and 2) must be modified. For example, if only the connectivity for elements 15 through 50 of a problem are available, the changes below would be made.

1. <u>All SAP IV Elements</u>

All SAP IV element control card changes would have similar changes because columns 6-10 contain the total number of group elements. Columns 66-70 are not used. Thus to plot only elements 15 through 50, make the following changes:

a. Enter the upper bound (i.e., 50) in columns 6-10.

b. Enter the lower bound (i.e., 15) in columns 66-70.

2. <u>ADINA Truss, 2D and 3D Elements</u>

ADINA element control cards for the truss, 2D continuum and the 3D continuum elements would be changed as follows:

a. Enter the upper bound (i.e., 50) in columns 5-8.

b. Enter the lower bound (i.e., 15) in columns 53-56.

3. <u>ADINA Beam Element</u>

ADINA element control cards for the beam element would be changed as follows:

a. Enter the upper bound (i.e., 50) in columns 5-8.

b. Enter the lower bound (i.e., 15) in columns 65-68.

APPENDIX B

SUBROUTINE PSAP1 LISTING

```
C
C
C     MAIN PROGRAM
C
C
      DIMENSION ZZZ(1400),DISPD(5,3,200)
       CALL PSAP1(ZZZ,1400,CISPD,200)
      STOP
      END
C          PSAP1
C
C
C     SUBROUTINE PSAP1 DOCUMENTATION
C
C
C
C                       DESCRIPTION OF INPUT CATA CARDS
C
C
C
C     TITLE CARD - 80 ALPHANUMERIC CHARACTERS CF GRAPH TITLE INFORMATION
C                  TO BE PRINTED ABOVE AND BELOW THE GRAPH. THE FIRST 40
C                  CHARACTERS WILL FORM THE FIRST TITLE LINE. THE LAST 40
C                  THE SECOND LINE.
C
C
C     NAMELIST OPTION - CONTAINS VALUES TO VERIFY STORAGE IN BLANK
C                       COMMON AND CONTROL VALUES NEEDED BY THE PROGRAM.
C
C         THE FOLLOWING VALUES ARE INCLUDED---
C
C         NNDEST = ESTIMATE NUMBER OF GRID POINTS TO BE USED.  VALUE MUST
C                  BE GREATER THAN OR EQUAL TO THE ACTUAL NUMBER OF GRID
C                 POINTS.
C              ** DEFAULT = 200 **
C         NUDISP = 0 FOR NO CISPLACEMENT DATA IN X-DIRECTION.
C                = 1 FOR DATA INCLUDING DISPLACEMENTS IN X-DIRECTION.
C              ** CEFAULT = 0 **
C         NVDISP = 0 FOR NO DISPLACEMENT DATA IN Y-DIRECTION.
C                = 1 FOR DATA INCLUDING DISPLACEMENTS IN Y-DIRECTION.
C              ** DEFAULT = 0 **
C         NWDISP = 0 FOR NO DISPLACEMENT DATA IN Z-DIRECTION.
C                = 1 FOR DATA INCLUDING DISPLACEMENTS IN Z-DIRECTION.
C              ** CEFAULT = 0 **
C
C         KGEOM SPECIFIES SUBROUTINE AND CORRESPONDING METHOD OF INPUT
C         FOR MODEL GEOMETRY.
C         KGEOM = 1 FOR USER SUPPLIED SUBROUTINE - GEOM1
```

```
C                  GEOM1 DEVELOPED TO READ ADINA GEOMETRY DATA - MAR 77
C              = 2 FOR USER SUPPLIED SUBROUTINE - GEOM2
C              = 9 FOR SAP IV DATA DECK INPUT SUBROUTINE - GEOM9.
C                  GEOM9 READS SAP IV GEOMETRY DATA - MODIFIED  MAR 77
C            ** DEFAULT = 9 **
C       KDATA SPECIFIES SUBROUTINE AND CORRESPONDING METHOD OF INPUT
C       FOR DISPLACEMENT DATA.
C       KDATA = 1 FOR SUBROUTINE DATA1 TO READ IN DISPLACEMENT DATA
C                -- SUPPLIED BY THE USER.
C             = 5 FOR SUBROUTINE DATA5 TO READ IN DISPLACEMENT DATA
C                 -- SUPPLIED BY THE USER.
C             = 9 FOR SUBROUTINE DATA9 TO READ SAP IV DATA.
C            ** DEFAULT = 9 **
C      NVALUS - NOT USED AT NPS ----- ALLOW DEFAULT
C
C            ** DEFAULT = 0 **
C        IRESEQ - NOT USED AT NPS ----- ALLOW TO DEFAULT
C            ** DEFAULT = 1 **
C       KPLOT SPECIFIES THE TYPE OF OUTPUT DEVICE TO BE USED.
C       KPLOT = 1 FOR CALCOMP.
C             = 2 FOR LANGLEY RESEARCH CENTER USE ONLY
C             = 3 FOR LRC USE ONLY.
C             = 4 FOR   LRC USE ONLY
C            ** DEFAULT = 1 **
C      YSPACE = SPACE BETWEEN PLOTS IN Y DIRECTION (INCHES) WHEN
C                MULTIPLE PLOTS ARE PRODUCED. YSPACE/2.0 IS SPACE
C                BETWEEN TITLE BLOCK AND PLOT.
C            ** DEFAULT = 2.0 **
C       PSIZE  =  PAPER SIZE IN X DIRECTION, USED IN SCALING OF
C                 PLOTS TO INSURE THIS DIMENSION IS NOT EXCEEDED.
C            ** DEFAULT = 9.0 **
C       IDCASE = 0 FOR NO TITLE CARD PRECEDING
C                  DECKS OF DISPLACEMENT VALUES.
C              = 1 FOR TITLE CARD PRECEDING
C                  DECKS OF DISPLACEMENT VALUES.
C            ** DEFAULT = 0 **



C    MODEL GEOMETRY IS NOW INPUT IN ONE OF THE FOLLOWING FORMS,
C       DEPENDING ON THE VALUE OF KGEOM SPECIFIED IN NAMELIST OPTION.
C
C
C      USE IF KGEOM = 1
C        CALL SUBROUTINE GEOM1 WHICH READS ADINA GEOMETRY DATA
C
C      USE IF KGEOM = 2
C        CALL SUBROUTINE GEOM2 WHICH IS PREPARED BY THE USER TO
```

```
C        READ GECMETRY DATA.
C
C
C
C      USE IF KGEOM = 9
C
C         CALL SUBROUTINE GECM9 WHICH READS SAP IV GEOMETRY DATA.
C
C
C
C     CASE IDENTIFICATION CARD.
C
C         THIS CARD IS OMITTED IF IDCASE=0 IS SPECIFIED IN &OPTION
C         IF PRESENT, THIS CARD CONTAINS ANY DESIRED ALPHANUMERIC
C         INFORMATION IN COLS.1-80 WILL NOT APPEAR ON PLOT BUT WILL
C         APPEAR ON PRINTOUT ABOVE DISPLACEMENT DATA
C
C
C     DATA TO BE PLOTTED IS NOW INPUT IN ONE OF THE FOLLOWING FORMS,
C         DEPENDING ON THE VALUE OF KDATA SPECIFIED IN NAMELIST OPTION.
C
C
C      USE IF KDATA = 1
C        CALL SUBROUTINE DATA1 WHICH IS PREPARED BY THE USER
C
C
C
C      USE IF KDATA = 5
C        CALL SUBROUTINE DATA5 WHICH IS PREPARED BY THE USER
C
C
C      USE IF KDATA = 9
C
C         CALL SUBROUTINE DATA9 WHICH READS SAP IV DISPLACEMENT DATA.
C         A DISPLACEMENT DATA DECK CAN BE PREPAIRED FOR ADINA IN A
C         FORMAT COMPATABLE WITH DATA9.
C
C
C
C
C      NAMELIST PICT - CONTAINS VALUES NEEDED TO GENERATE PLOTS.
C
C         THE FOLLOWING VALUES ARE INCLUDED---
C
C         KHORZ = INTEGER DESIGNATING HORIZONTAL AXIS OF VIEWING PLANE,
C                   WHERE 1=X, 2=Y, 3=Z.
C              ** DEFAULT = 1 **
C         KVERT = INTEGER DESIGNATING VERTICAL AXIS OF VIEWING PLANE,
```

```
C             WHERE 1=X, 2=Y, 3=Z.
C          ** DEFAULT = 2 **
C      PHI = ANGULAR ROTATION OF MODEL ABOUT ITS X-AXIS, IN DEGREES
C            (MLST BE TAKEN THIRD).
C          ** DEFAULT = 0.0 **
C      THETA = ANGULAR RCTATION OF MODEL ABOUT ITS Y-AXIS, IN DEGREES
C            (MUST BE TAKEN SECOND).
C          ** DEFAULT = 0.0 **
C      PSI = ANGULAR ROTATION OF MODEL ABOUT ITS Z-AXIS, IN DEGREES
C            (MUST BE TAKEN FIRST).
C          ** DEFAULT = 0.0 **
C      NEWFR = 1 FOR FRAME CHANGE BEFORE PLOT IS MADE.
C              (A FRAME CHANGE RESETS THE Y-ORGIN PAST PREVIOUS PLOT
C               BY YSPACE AND X ORIGIN AT 0.0)
C               NEWFR.NE.1 FOR NO FRAME CHANGE BEFORE PLOTTING
C          ** DEFAULT = 1 **
C      ISCALE = 1 FOR INTERNAL ORIGIN LOCATION AND SCALING.
C             = 2 FOR USER SPECIFIED ORIGIN AND SCALING.
C             = 0 FOR NO SCALE CHANGE.(I.E. USE SAME SCALE AS PREVIOUS
C               PLOT) THIS IS USEFUL IN AN ASSEMBLY GRAPH WHERE IT IS
C               NECESSARY TO EXAMINE A MESH IN SECTIONS WITHOUT LOSING
C               PERSPECTIVE. ISCALE CANNOT BE ZERO ON THE FIRST PLOT.
C          ** DEFAULT = 1 **
C      PLOTSZ = MAXIMUM DIMENSION DESIRED ON COMPLETED PLOT.
C               (USED FOR SCALING IF ISCALE = 1)
C               PLOTSZ SCALES THE PLOT PRIOR TO ROTATION. IF ROTATION
C               CAUSES THE PLOT TO EXCEED PAPER WIDTH (PSIZE), IT IS
C               RESCALED AND THE PLOT SIZE IS REDUCED ACCORDINGLY.
C          ** DEFAULT = 10.0 **
C      XORGN = X-LOCATION OF PLOT ORIGIN (USED IF ISCALE = 2).
C          ** DEFAULT = 0.0 **
C      YORGN = Y-LOCATION OF PLOT ORIGIN (USED IF ISCALE = 2).
C          ** DEFAULT = 0.0 **
C      PSCALE = MODEL SIZE REDUCTION FACTOR, PSCALE = ACTUAL MODEL
C               SIZE/DESIRED PLOT SIZE (USED IF ISCALE = 2).
C          ** DEFAULT = 1.0 **
C      NOTAT = 0 FOR NO NUMBERING ON PLOTS.
C            = 1 FOR NUMBERING OF GRID POINTS.
C            = 2 FOR NUMBERING OF ELEMENTS.
C          ** DEFAULT = 0 **
C      XLHT = HEIGHT OF INTEGERS SPECIFIED BY NCTAT, IN INCHES.
C          ** DEFAULT = 0.15 **
C      KDISP = 0 FOR UNDEFORMED PLOT.
C            = 1 FOR DEFORMED PLOT.
C            = 2 FOR EXPLODED PLOT.
C            = 3 FOR DISPLACEMENTS REPRESENTED BY VECTORS.
C          ** DEFAULT = 0 **
C      ICMAG = 1 FOR DIRECT SCALING OF DATA BY DMAGS.
```

```
C              = 2 FOR SCALING OF DATA TO A MAX. VALUE OF DMAGS.
C           ** DEFAULT = 2 **
C        DMAGS = MAGNIFICATION OF DISPLACEMENTS (IF KDISP=1).
C              = REDUCTION FACTOR OF ELEMENTS (IF KDISP=2).
C           ** DEFAULT = 1.0 **
C        KSYMXY = 1 FOR SYMMETRY ABOUT X-Y PLANE.
C           ** DEFAULT = 0 **
C        KSYMXZ = 1 FOR SYMMETRY ABOUT X-Z PLANE.
C           ** DEFAULT = 0 **
C        KSYMYZ = 1 FOR SYMMETRY ABOUT Y-Z PLANE.
C           ** DEFAULT = 0 **
C        XXMAX,YYMAX,ZZMAX,XXMIN,YYMIN,ZZMIN LOCATE CUTTING PLANES
C           PARALLEL TO PRINCIPAL (X-Y,X-Z,Y-Z) PLANES
C           TO LIMIT PLOT.
C           ** DEFAULT XXMAX=YYMAX=ZZMAX=1.0E+20 **
C           ** DEFAULT XXMIN=YYMIN=ZZMIN=-1.0E+20 **
C        NDMAX = MAXIMUM GRID PT. TO BE INCLUDED IN PLOT.
C           ** DEFAULT = 9999999999 **
C        NDMIN = MINIMUM GRID PT. TO BE INCLUDED IN PLOT.
C           ** DEFAULT = 0 **
C        NELMAX = MAXIMUM ELEMENT NUMBER TO BE INCLUDED IN PLOT.
C           ** DEFAULT = 9999999999 **
C        NELMIN = MINIMUM ELEMENT NUMBER TO BE INCLUDED IN PLOT.
C           ** DEFAULT = 0 **
C        KODE SPECIFIES CONTROL OPTION AFTER PLOT IS COMPLETE.
C        KODE = 0, LAST PLOT, EXIT FROM PROGRAM.
C           = 1, READ ANOTHER NAMELIST PICT.
C           = 2, READ A NEW SET OF DISPLACEMENT DATA, INCLUDING A
C                CASE IDENTIFICATION CARD IF PRESENT.
C           = 3, READ A COMPLETE NEW SET OF INPUT DATA,
C                INCLUDING A TITLE CARD.
C           ** DEFAULT = 0 **



C     THE ABOVE COMPRISES A COMPLETE BASIC SET OF INPUT DATA IF
C     KODE = 0 IN &PICT.  FOR KODE = 1, 2, OR 3, ADDITIONAL SECTIONS OF
C     THE BASIC DECK MUST BE REPEATED.  THE DECK MUST END WITH
C     NAMELIST &PICT HAVING KODE = 0.
C
C
C
C*************************************************************************
C
C
C                    DESCRIPTION OF GRAPHICS SUBROUTINES
C
C
```

```
C
C        THE SUBROUTINES USED IN THE ACTUAL CREATION OF PLOTS BY
C        THE CALCOMP MODEL 765 CAN BE FOUND IN NPS TECHNICAL NOTE
C        NUMBER 0211-03, "PLOTTING PACKAGE FOR NPS IBM 360/367".
C
C
C
C*********************************************************************
C
C
C
C
C       SUBROUTINE PSAP1 IS A MODIFICATION TO NAVAL POSTGRADUATE
C       SCHOOL THESIS BY LT. D. M. LOSH , DECEMBER 1976.  MODIFICATION
C       INCLUDED SAP IV 8-21 NODE BRICK ELEMENTS,BOUNDARY ELEMENTS AND
C       ADINA TRUSS,PLANE,BRICK ,BEAM ELEMENTS,AND OTHER MINOR
C       IMPROVEMENTS.
C
C
C     MODIFIED BY  ADRIAN E. KIBLER JR.
C                  LT            USN
C                  NAVAL POSTGRADUATE SCHOOL
C                  MONTEREY,CA.
C                  JAN - JUN 1977
C
C*********************************************************************
C
C
      SUBROUTINE PSAP1(ZZZ,NZ,DISPD,NON)
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C
C *** THIS IS THE MAIN SUBROUTINE WHICH CALLS OTHER SUBROUTINES
C
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      INTEGER NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT
      COMMON/CDATA/NTIME,NTLC
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KODE
      COMMON/LIMITS/ XXMAX,YYMAX,ZZMAX,XXMIN,YYMIN,ZZMIN,NDMAX,NDMIN,
     1NELMAX,NELMIN
      COMMON/CORGN/ YPMAX,YSPACE,PSIZE
      COMMON/GLOOP/ ILOOP
```

```
      COMMON/ABLK/ A(3,3)
      COMMON/SAVEV/ DMAGS, IDMAG
      COMMON/KOUNT/ NNODE,NNDEST,NUDISP,NVDISP,NWDISP
      COMMON/VALUES/ NVALUS
      COMMON/CASEID/ IDCASE
      DIMENSION ZZZ(NZ),DISPD(5,3,NON),ABCD1(10),ABCD2(10),ABCD3(10),
     1ABCD4(10)
      NAMELIST/PICT/ KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,
     1PLOTSZ,XORGN,YORGN,PSCALE,NOTAT,KDISP,IDMAG,DMAGS,KODE,
     2KSYMXY,KSYMXZ,KSYMYZ,XXMAX,YYMAX,ZZMAX,XXMIN,
     3YYMIN,ZZMIN,NDMAX,NDMIN,NELMAX,NELMIN,XLHT
C
C *** TO ZERO NODE AND ELEMENT SUMMATION COUNTERS
C
      ILOOP = 0
      NNODE = 0
      YPMAX=0.0
C
C *** TO DEFINE THE ORIGIN AND OPEN PLOTING DATA SETS
C
      CALL CALCMP
      CALL CALPLT(-10.0,0.0,-3)
      CALL CALPLT(1.0,6.0,-3)
  500 CONTINUE
      REWIND 10
      WRITE(6,8)
    8 FORMAT(1H1)
C
C *** TO READ TITLE CARD FOR RUN
C
      READ(5,9004,END=999) (ABCD1(I),I=1,10),(ABCD2(I),I=1,10)
 9004 FORMAT(20A4)
      WRITE(6,9006) (ABCD1(I),I=1,10),(ABCD2(I),I=1,10)
 9006 FORMAT (///,20X,20A4////)
      CALL INITAL
C
C *** TO PLOT THE TITLE CARD AT THE BEGINING OF THE PLOT
C
      CALL CALPLT(0.3,1.62,3)
      CALL CALPLT(0.0,0.62,2)
      CALL CALPLT(0.0,0.0,2)
      CALL CALPLT(9.0,0.0,2)
      CALL NOTATE(0.8,0.41,0.21,ABCD1,0.0,40)
      CALL NOTATE(0.8,0.10,0.21,ABCD2,0.0,40)
      CALL CALPLT(0.0,1.62+YSPACE/2.0,-3)
C
C *** TO SET POINTERS FOR BLANK COMMON STORAGE ZZZ
C *** (WITH INTEGER NAMES OF ARRAYS USED IN CALLED SUBROUTINES)
```

```
C
      NUMPT = 1
      XPT = NUMPT+NNDEST
      YPT = XPT+NNDEST
      ZPT = YPT+NNDEST
      UPT = ZPT+NNDEST
      IF(NUDISP.EQ.0) VPT = UPT+1
      IF(NUDISP.NE.0) VPT = UPT+NNDEST
      IF(NVDISP.EQ.0) WPT = VPT+1
      IF(NVDISP.NE.0) WPT = VPT+NNDEST
      IF(NWDISP.EQ.0) NEND = WPT+1-1
      IF(NWDISP.NE.0) NEND = WPT+NNDEST-1
      WRITE(6,15) NEND
   15 FORMAT(///,20X,'BLANK COMMON STORAGE ZZZ REQUIRES AT LEAST ',I6,
     1' LOCATIONS FOR THIS CASE'///)
      IF(KGEOM.EQ.1) CALL GEOM1
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
      IF(KGEOM.EQ.2) CALL GEOM2
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
      IF(KGEOM.EQ.9) CALL GEOM9
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
      CALL PNTOUT(1,
     1ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
  600 CONTINUE
      IF(IDCASE.EQ.0) GO TO 650
      READ(5,9004,END=999) (ABCD3(I),I=1,10),(ABCD4(I),I=1,10)
      WRITE(6,9006) (ABCD3(I),I=1,10),(ABCD4(I),I=1,10)
  650 CONTINUE
      CALL ZEROD
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
      IF(KDATA.EQ.1) CALL DATA1
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
      IF(KDATA.EQ.5) CALL DATA5
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
      IF(KDATA.EQ.9) CALL DATA9
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT),
     2DISPD,NCN)
      IF (NUDISP.EQ.0.AND.NVDISP.EQ.0.AND.NWDISP.EQ.0) GO TO 700
      CALL PNTOUT(2,
     1ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
  700 CONTINUE
      IF(KPLOT.EQ.4.AND.ILOOP.NE.0) GO TO 6000
      WRITE (6,1000)
 1000 FORMAT(///)
      READ(5,PICT)
      WRITE(6,PICT)
 6000 CONTINUE
      CALL DSCALE
```

```
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
      CALL BOLND
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
      IF(ISCALE.NE.0) CALL RCTAT
      CALL PLOTX
     1(ZZZ(NUMPT),ZZZ(XPT),ZZZ(YPT),ZZZ(ZPT),ZZZ(UPT),ZZZ(VPT),ZZZ(WPT))
      ILOOP=ILOCP+1
      GO TO (70C,600),KODE
C
C *** TO PLOT TITLE ON TOP CF GRAPH IF KODE = 3
C *** TO PLOT TITLE ON TOP AND CLOSE PLOTING DATA SETS IF KODE = 0
C
      CALL CALPLT(0.0,YPMAX+YSPACE/2.0,-3)
      CALL CALPLT(0.3,0.0,3)
      CALL CALPLT(0.0,1.0,2)
      CALL CALPLT(0.0,1.62,2)
      CALL CALPLT(9.0,1.62,2)
      CALL NOTATE(0.8,1.31,.21,ABCD1,0.0,40)
      CALL NOTATE(0.8,1.0,.21,ABCD2,0.0,40)
      CALL CALPLT(0.0,1.62+YSPACE,-3)
      ILOOP=0
      IF(KODE.EQ.3) GO TO 500
      WRITE(6,9008)
 9008 FORMAT(//,5X,'TERMINATICN NORMAL DUE TO KODE = 0')
      CALL PSTOP
      RETURN
  999 CALL ERROR(2)
      RETURN
      END
      SUBROUTINE PSTOP
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C
C *** TO TERMINATE JOB.
C *** THIS SUBROUTINE IS CALLED BY ERROR AND PSAP1. IN BOTH CASES
C *** PLOTTER PEN HAS BEEN RETURNED TO THE ORGIN AND PLOTTER ADVANCED.
C
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KODE
      CALL PLCTE
      STOP
      END
      SUBROUTINE INITAL
```

```
C
C  *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C
C  *** TO SET UP VALUES FOR CONTROL PARAMETERS
C  *** CALLED BY PSAP1
C
C
C  *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      COMMON/CDATA/NTIME,NTLC
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KCDE
      COMMON/LIMITS/ XXMAX,YYMAX,ZZMAX,XXMIN,YYMIN,ZZMIN,NDMAX,NDMIN,
     1NELMAX,NELMIN
      COMMON/CORGN/ YPMAX,YSFACE,PSIZE
      COMMON/SAVEV/ DMAGS,IDMAG
      COMMON/KOUNT/ NNODE,NNDEST,NUDISP,NVDISP,NWDISP
      COMMON/SEQNCE/ IRESEQ
      COMMON/VALUES/ NVALUS
      COMMON/CASEID/ IDCASE
      NAMELIST/OPTION/ NNDEST,NUDISP,NVDISP,NWDISP,
     1KGEOM,KDATA,NVALUS,IRESEQ,KPLOT,YSPACE,PSIZE,IDCASE
C
C  *** DESCRIPTION OF VALUES IN &OPTION GIVEN IN SUBROUTINE DOCMNT
C
C
C  *** TO SET DEFAULT VALUES FOR &OPTION
C
      NNDEST = 200
      NUDISP=0
      NVDISP=0
      NWDISP=0
      KGEOM=9
      KDATA=9
      NTIME=0
      NVALUS = 0
      IRESEQ = 1
      KPLOT = 1
      YSPACE=2.0
      PSIZE=9.0
      IDCASE = 0
C
C  *** TO SET DEFAULT VALUES FOR &PICT
C
      KHORZ = 1
      KVERT = 2
```

```
      PHI = 0.0
      THETA = 0.0
      PSI = 0.0
      NEWFR = 1
      ISCALE = 1
      PLOTSZ = 10.0
      XORGN = 0.0
      YORGN = 0.0
      PSCALE = 1.0
      NOTAT = 0
      XLHT = 0.1400
      KDISP = 0
      IDMAG = 2
      DMAGS = 1.0
      KSYMXY = 0
      KSYMXZ = 0
      KSYMYZ = 0
      XXMAX = 1.0E20
      YYMAX = 1.0E20
      ZZMAX = 1.0E20
      XXMIN = -1.0E20
      YYMIN = -1.0E20
      ZZMIN = -1.0E20
      NDMAX = 9999999
      NDMIN = 0
      NELMAX = 9999999
      NELMIN = 0
      KODE = 0
      READ(5,OPTION,END=999)
      WRITE(6,9010)
 9010 FORMAT(////)
      WRITE(6,OPTION)
      WRITE(6,9010)
      RETURN
  999 CALL ERROR(3)
      RETURN
      END
      SUBROUTINE BOUND(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
C  *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C *** TO DETERMINE MAXIMUM DIMENSIONAL LIMITS OF BODY FOR USE
C     IN SCALING PLOTS
C *** CALLED BY PSAP1
C
C  *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
```

```
      1KHURZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
      2PSCALE,KDISP,DMAG,KODE
       COMMON/LIMITS/ XXMAX,YYMAX,ZZMAX,XXMIN,YYMIN,ZZMIN,NDMAX,NDMIN,
      1NELMAX,NELPIN
       COMMON/XYZLIM/ XYZMAX(3),XYZMIN(3)
       COMMON/KOUNT/ NNODE,NNCEST,NUDISP,NVDISP,NWDISP
       DIMENSION NUMPT(1),XPT(1),YPT(1),ZPT(1),UPT(1),VPT(1),WPT(1)
       DIMENSION NODE(20)
       DO 5 I=1,3
       XYZMIN(I) = +1.0E20
       XYZMAX(I) = -1.0E20
     5 CONTINUE
       REWIND 10
   100 CONTINUE
       READ(10,END=1000) NEND,NUMEL,(NODE(I),I=1,NEND)
       IF(NUMEL.LT.NELMIN.OR.NUMEL.GT.NELMAX) GO TO 100
       DO 10 I=1,NEND
       ND = NODE(I)
       IF(NODE(I).EQ.0) GO TO 10
       IF(NUMPT(ND).LT.NDMIK.CR.NUMPT(ND).GT.NDMAX) GO TO 100
    10 CONTINUE
       DO 20 I=1,NEND
       IF(NODE(I).EQ.0) GC TC 20
       ND = NODE(I)
       IF(XPT(ND).GT.XXMAX) GO TO 20
       IF(XPT(ND).LT.XXMIN) GO TO 20
       IF(YPT(ND).GT.YYMAX) GO TO 20
       IF(YPT(ND).LT.YYMIN) GO TO 20
       IF(ZPT(ND).GT.ZZMAX) GO TO 20
       IF(ZPT(ND).LT.ZZMIN) GO TO 20
       IF(XPT(ND).GT.XYZMAX(1)) XYZMAX(1) = XPT(ND)
       IF(XPT(ND).LT.XYZMIN(1)) XYZMIN(1) = XPT(ND)
       IF(YPT(ND).GT.XYZMAX(2)) XYZMAX(2) = YPT(ND)
       IF(YPT(ND).LT.XYZMIN(2)) XYZMIN(2) = YPT(ND)
       IF(ZPT(ND).GT.XYZMAX(3)) XYZMAX(3) = ZPT(ND)
       IF(ZPT(ND).LT.XYZMIN(3)) XYZMIN(3) = ZPT(NC)
    20 CONTINUE
       GO TO 100
  100C CONTINUE
       DO 300 I=1,3
       IF(I.EQ.1.AND.KSYMYZ.NE.1) GO TO 300
       IF(I.EQ.2.AND.KSYMXZ.NE.1) GO TO 300
       IF(I.EQ.3.AND.KSYMXY.NE.1) GO TO 300
       XYZBIG = ABS(XYZMAX(I))
       IF(ABS(XYZMIN(I)).GT.XYZBIG) XYZBIG = ABS(XYZMIN(I))
       XYZMAX(I) = XYZBIG
       XYZMIN(I) = -XYZBIG
   300 CONTINUE
```

```
      RETURN
      END
      SUBROUTINE ZEROD(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C *** INITIALIZES ALL DISPLACEMENTS TO ZERO.
C *** CALLED BY PSAP1
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      COMMON/KOUNT/ NNODE,NNDEST,NUDISP,NVDISP,NWDISP
      DIMENSION NUMPT(1),XPT(1),YPT(1),ZPT(1),UPT(1),VPT(1),WPT(1)
      IF(NUDISP.EQ.0) GO TO 200
      DO 150 I=1,NUDISP
      UPT(I) = 0.0
  150 CONTINUE
  200 CONTINUE
      IF(NVDISP.EQ.0) GO TO 300
      DO 250 I=1,NVDISP
      VPT(I) = 0.0
  250 CONTINUE
  300 CONTINUE
      IF(NWDISP.EQ.0) GO TO 400
      DO 350 I=1,NWDISP
      WPT(I) = 0.0
  350 CONTINUE
  400 CONTINUE
      RETURN
      END
      SUBROUTINE PNTOUT(IOUT,NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C *** FOR PRINTED OUTPUT OF INFORMATION IN BLANK COMMON - ZZZ
C *** CALLED BY PSAP1
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      COMMON/KOUNT/ NNODE,NNDEST,NUDISP,NVDISP,NWDISP
      DIMENSION NUMPT(1),XPT(1),YPT(1),ZPT(1),UPT(1),VPT(1),WPT(1)
      DIMENSION NODE(20)
      GO TO (1000,2000), IOUT
 1000 CONTINUE
C
C *** FOR OUTPUT OF GEOMETRY INFORMATION
C
      WRITE(6,16)
```

```
   16 FORMAT(///,5X,'GRID FCINT INFORMATION',///)
      WRITE(6,17)
   17 FORMAT(5X,'RESEQUENCED',4X,'USER INPUT'/
     15X,'GRID PCINT',5X,'GRID PCINT'/
     25X,'NUMBER',9X,'NUMBER',13X,'X',14X,'Y',14X,'Z'//)
      DO 30 I=1,NNODE
      WRITE(6,18) I,NUMPT(I),XPT(I),YPT(I),ZPT(I)
   18 FORMAT(2X,I10,5X,I10,3X,3E15.4)
   30 CONTINUE
      WRITE(6,19)
   19 FORMAT(///,5X,'ELEMENT INFORMATION - WITH RESEQUENCED GRID POINTS
     1'///)
      WRITE (6,9008)
 9008 FORMAT(1X,'RESEQUENCED',4X,'USER INPUT',25X,'GRID POINTS'/
     11X,'ELEMENT',8X,'ELEMENT'/
     21X,'NUMBER',9X,'NUMBER',7X,'     1    2    3    4    5    6    7
     3 8    9   10   11   12   13   14   15   16   17   18   19   20'//)
      REWIND 10
      I = 0
   35 CONTINUE
      I = I+1
      READ(10,END=999) NEND,NUMEL,(NODE(J),J=1,NEND)
      IF(NEND.EQ.12) GO TC 40
      WRITE(6,9010) I,NUMEL,(NODE(J),J=1,NEND)
 9010 FORMAT(1X,I4,11X,I4,9X,20I5)
      GO TO 35
   40 WRITE(6,9010) I,NUMEL,(NODE(J),J=1,4),(NODE(J),J=9,12)
      GO TO 35
 2000 CONTINUE
C
C *** FOR OUTPUT OF DISPLACEMENT DATA
C
      WRITE(6,210)
  210 FORMAT(///,5X,'DISPLACEMENTS TO BE PLOTTED',///)
      WRITE(6,17)
      DO 230 I=1,NNODE
      U = 0.0
      IF(NUDISP.NE.0) U = UPT(I)
      V = 0.0
      IF(NVDISP.NE.0) V = VPT(I)
      W = 0.0
      IF(NWDISP.NE.0) W = WPT(I)
      WRITE(6,18) I,NUMPT(I),U,V,W
  230 CONTINUE
  999 RETURN
      END
      SUBROUTINE PLOTX(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
```

```
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** FOR GENERATING PLOTS.
C *** CALLED BY PSAP1
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KODE
      COMMON/LIMITS/ XXMAX,YYMAX,ZZMAX,XXMIN,YYMIN,ZZMIN,NDMAX,NDMIN,
     1NELMAX,NELMIN
      COMMON/XYZLIM/ XYZMAX(3),XYZMIN(3)
      COMMON/CORGN/ YPMAX,YSPACE,PSIZE
      COMMON/GLOOP/ ILOOP
      COMMON/ABLK/ A(3,3)
      COMMON/KOUNT/ NNODE,NNDEST,NUDISP,NVDISP,NWDISP
      COMMON/PDELS/ DELX,DELY
      DIMENSION NUMPT(1),XPT(1),YPT(1),ZPT(1),UPT(1),VPT(1),WPT(1)
      DIMENSION NODE(20),X(20),Y(20),Z(20),XDISP(20),YDISP(20),
     1ZDISP(20),XROT(20),YROT(20),XP(21),YP(21)
C
C *** TO MAKE ALL GRID POINT NUMBERS NEGATIVE
C
      DO 50 I=1,NNODE
      IF(NUMPT(I).GT.0) NUMPT(I)=-NUMPT(I)
   50 CONTINUE
C
C *** TO MAKE FRAME CHANGE IF NEWFR = 1
C ***      NO FRAME CHANGE ON FIRST PLOT AFTER NAMELIST OPTION
C
      YMOVE=0.0
      IF(ILOOP.EQ.0) GO TO 70
      IF(NEWFR.EQ.1) YMOVE=YPMAX+YSPACE
   70 CALL CALPLT(0.0,YMOVE,-3)
      GO TO (710,710,703,710),KPLOT
  703 CONTINUE
      IF(NEWFR.EQ.1) CALL NFRAME
  710 CONTINUE
      IF(ISCALE.NE.0) DELX=0.0
      IF(ISCALE.NE.0) DELY=0.0
      IF(ISCALE.EQ.1) CALL XYSCAL
      CALL CALPLT(XORGN,YORGN,-3)
      XSHIFT = 0.0
      YSHIFT = 0.0
      ZSHIFT = 0.0
      YPMAX=-1.0E20
C
```

```
C *** LOOPS TO ACCOUNT FOR SYMMETRY
C
      ZSIGN = +1.0
      DO 500 II=1,2
      IF(II.EQ.2.AND.KSYMXY.NE.1) GO TO 500
      IF(II.EQ.2.AND.KSYMXY.EQ.1) ZSIGN = -1.0
      YSIGN = +1.0
      DO 510 JJ=1,2
      IF(JJ.EQ.2.AND.KSYMXZ.NE.1) GO TO 510
      IF(JJ.EQ.2.AND.KSYMXZ.EQ.1) YSIGN = -1.0
      XSIGN = +1.0
      DO 520 KK=1,2
      IF(KK.EQ.2.AND.KSYMYZ.NE.1) GO TO 520
      IF(KK.EQ.2.AND.KSYMYZ.EQ.1) XSIGN = -1.0
C
C *** TO DETERMINE PROJECTED COORDINATES OF ELEMENTS
C
      REWIND 10
  100 CONTINUE
      READ(10,END=1000) NEND,NUMEL,(NODE(J),J=1,NEND)
      IF(NUMEL.LT.NELMIN.OR.NUMEL.GT.NELMAX) GO TO 100
      DO 10 I=1,NEND
      ND = NODE(I)
      IF(NODE(I).EQ.0)GO TO 10
C
C *** TO MAKE GRID POINT NUMBERS CONNECTED BY ELEMENTS POSITIVE
      NUMPT(ND) = IABS(NUMPT(ND))
      IF(NUMPT(ND).LT.NDMIN.OR.NUMPT(ND).GT.NDMAX ) GO TO 100
   10 CONTINUE
      I = KHORZ
      J = KVERT
      DO 20 N=1,NEND
      IF(NODE(N).EQ.0) GO TO 20
      ND = NODE(N)
      IF(XPT(ND).GT.XXMAX) GO TO 100
      IF(XPT(ND).LT.XXMIN) GO TO 100
      IF(YPT(ND).GT.YYMAX) GO TO 100
      IF(YPT(ND).LT.YYMIN) GO TO 100
      IF(ZPT(ND).GT.ZZMAX) GO TO 100
      IF(ZPT(ND).LT.ZZMIN) GO TO 100
      XDISP(N) = 0.0
      YDISP(N) = 0.0
      ZDISP(N) = 0.0
      IF(KDISP.EQ.1.AND.NUDISP.NE.0) XDISP(N) = UPT(ND)
      IF(KDISP.EQ.1.AND.NVDISP.NE.0) YDISP(N) = VPT(ND)
      IF(KDISP.EQ.1.AND.NWDISP.NE.0) ZDISP(N) = WPT(ND)
      X(N) = XSIGN*(XPT(ND)+XDISP(N)*DMAG+XSHIFT)/PSCALE
      Y(N) = YSIGN*(YPT(ND)+YDISP(N)*DMAG+YSHIFT)/PSCALE
```

```
      Z(N) = ZSIGN*(ZPT(NO)+ZDISP(N)*DMAG+ZSHIFT)/PSCALE
   20 CONTINUE
      IF(KDISP.EQ.2) CALL XPLOD(NEND,X,Y,Z,NODE)
      XCENT = 0.0
      YCENT = 0.0
      FND=0.0
      DO 25 N=1,NEND
      IF(NODE(N).EQ.0) GO TO 25
      XROT(N) = A(I,1)*X(N)+A(I,2)*Y(N)+A(I,3)*Z(N)
      YROT(N) = A(J,1)*X(N)+A(J,2)*Y(N)+A(J,3)*Z(N)
      IF(N.GT.8) GO TO 24
      FND=FND+1.0
      XCENT = XCENT+XROT(N)
      YCENT = YCENT+YROT(N)
   24 CONTINUE
      XROT(N) = XROT(N)+DELX
      YROT(N) = YROT(N)+DELY
       IF(YROT(N).GT.YPMAX) YPMAX=YROT(N)
   25 CONTINUE
      IF(NOTAT.NE.2) GO TO 29
      XCENT = XCENT/FND-(6.0/7.0)*XLHT
      YCENT = YCENT/FND-XLHT/2.0
      XCENT = XCENT+DELX
      YCENT = YCENT+DELY
      AL = NUMEL
C *** SUBROUTINE NUMBER APPLIES ONLY TO CALCOMP
   29 CONTINUE
      IF(NOTAT.EQ.2) CALL NUMBER(XCENT,YCENT,XLHT,AL,0.0,-1)
C
C *** TO PLOT ELEMENTS
C
      IF(NEND.EQ.2) GO TO 280
      IF(NEND.EQ.4) GO TO 300
      IF(NEND.EQ.8) GO TO 320
      IF(NEND.EQ.12) GO TO 340
      IF(NEND.EQ.20) GO TO 340
      CALL ERROR(4)
C
C ***TO PLOT 2 NODE ELEMENT
C
  280 CONTINUE
      CALL CALPLT(XROT(1),YROT(1),3)
      CALL CALPLT(XROT(2),YROT(2),2)
      GO TO 430
C
C *** TO PLOT 3 AND 4 NODE PLANE ELEMENT
C
  300 CONTINUE
```

```
      CALL CALPLT(XROT(1),YROT(1),3)
      DO 305 NP=2,NEND
      CALL CALPLT(XROT(NP),YROT(NP),2)
  305 CONTINUE
      CALL CALPLT(XROT(1),YROT(1),2)
      GO TO 430
C
C *** TO PLOT 8 NODE 3-D BRICK
C
  320 CONTINUE
      LP=1
      DO 330 NP=2,6,4
         NP2=NP+2
         CALL CALPLT(XROT(LP),YROT(LP),3)
         DO 325 MP=NP,NP2
            CALL CALPLT(XROT(MP),YROT(MP),2)
  325       CONTINUE
         CALL CALPLT( XROT(LP),YROT(LP),2)
         LP=LP+4
  330    CONTINUE
      DO 335 NP=1,4
         NP4=NP+4
         CALL CALPLT( XROT(NP),YROT(NP),3)
         CALL CALPLT( XROT(NP4),YROT(NP4),2)
  335    CONTINUE
      GO TO 430
C
C *** TO PLOT VARIABLE 4-8 NODE PLANE AND 8-20 NODE BRICK ELEMENTS
C *** NOTE  SUBROUTINE LINE ONLY APPLIES TO THE CALCOMP PLOTTER
C
  340 CONTINUE
      LP=1
      KP=8
      DO 365 NP=2,6,4
         NP2=NP+2
         CALL CALPLT(XROT(LP),YROT(LP),3)
         DO 345 MP=NP,NP2
            KP=KP+1
            N=2
            CALL WHERE(XP(1),YP(1))
            XP(2)=XROT(MP)
            YP(2)=YROT(MP)
            XP(3)=XROT(KP)
            YP(3)=YROT(KP)
            IF(NODE(KP).NE.0) CALL CURVE(XP,YP,N)
            CALL LINE(XP,YP,N,1,1)
  345       CONTINUE
         KP=KP+1
```

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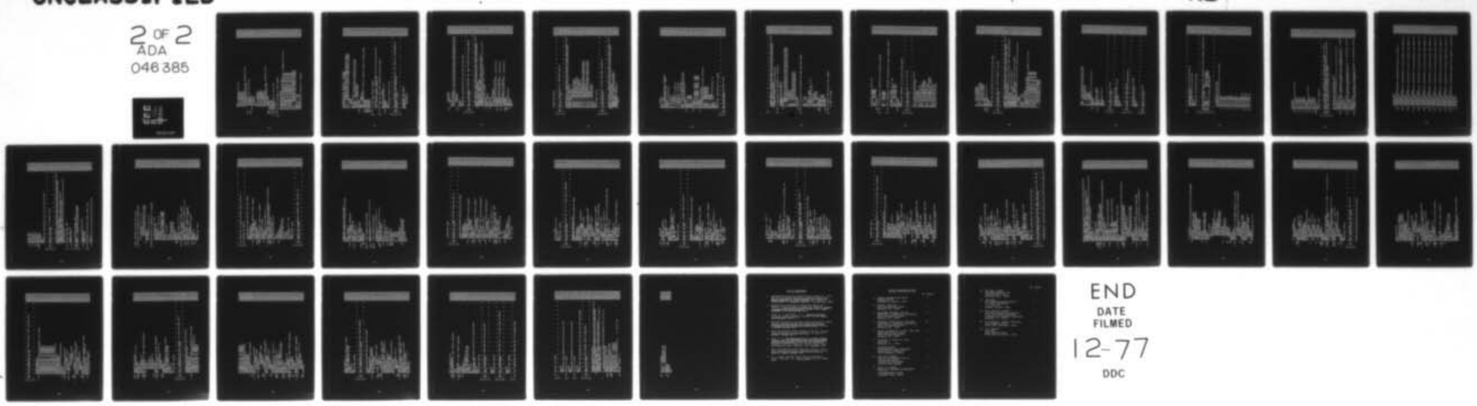

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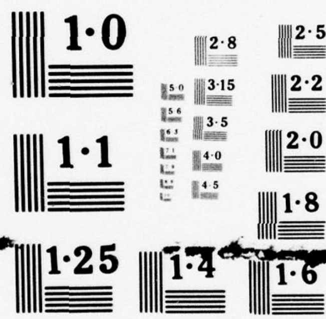

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```
      N=2
      CALL WHERE(XP(1),YP(1))
      XP(2)=XROT(LP)
      YP(2)=YROT(LP)
      XP(3)=XROT(KP)
      YP(3)=YROT(KP)
      IF(NODE(KP).NE.0) CALL CURVE(XP,YP,N)
      CALL LINE(XP,YP,N,1,1)
  355   LP=LP+4
        IF(NEND.EQ.12) GO TO 430
  365   CONTINUE
      DO 390 NP=1,4
        NP4=NP+4
        KP=NP+16
      N=2
      XP(1)=XROT(NP)
      YP(1)=YROT(NP)
      XP(2)=XROT(NP4)
      YP(2)=YROT(NP4)
      XP(3)=XROT(KP)
      YP(3)=YROT(KP)
      IF(NODE(KP).NE.0) CALL CURVE(XP,YP,N)
      CALL LINE(XP,YP,N,1,1)
  390   CONTINUE
  430 CONTINUE
      GO TO 100
 1000 CONTINUE
      IF(KDISP.NE.3) GO TO 650
  600 CONTINUE
C
C *** TO PLOT VECTORS AT GRID POINTS
C
      DO 601 ND=1,NNODE
      IF(NUMPT(ND).LE.0) GO TO 601
      IF(NUMPT(ND).LT.NDMIN.OR.NUMPT(ND).GT.NDMAX) GO TO 601
      IF(XPT(ND).GT.XYZMAX(1)) GO TO 601
      IF(XPT(ND).LT.XYZMIN(1)) GO TO 601
      IF(YPT(ND).GT.XYZMAX(2)) GO TO 601
      IF(YPT(ND).LT.XYZMIN(2)) GO TO 601
      IF(ZPT(ND).GT.XYZMAX(3)) GO TO 601
      IF(ZPT(ND).LT.XYZMIN(3)) GO TO 601
      X(1) = XSIGN*(XPT(ND)+XSHIFT)/PSCALE
      Y(1) = YSIGN*(YPT(ND)+YSHIFT)/PSCALE
      Z(1) = ZSIGN*(ZPT(ND)+ZSHIFT)/PSCALE
      XDISP(1) = 0.0
      YDISP(1) = 0.0
      ZDISP(1) = 0.0
      IF(NUDISP.NE.0) XDISP(1) = UPT(ND)
```

```
      IF(NVDISP.NE.0) YDISP(1) = VPT(ND)
      IF(NWDISP.NE.0) ZCISF(1) = WPT(ND)
      X(2) = XSIGN*(XPT(ND)+XDISP(1)*DMAG+XSHIFT)/PSCALE
      Y(2) = YSIGN*(YPT(ND)+YDISP(1)*DMAG+XSHIFT)/PSCALE
      Z(2) = ZSIGN*(ZPT(NC)+ZDISP(1)*DMAG+ZSHIFT)/PSCALE
      I = KHORZ
      J = KVERT
      DO 605 N=1,2
      XROT(N) = A(I,1)*X(N)+A(I,2)*Y(N)+A(I,3)*Z(N)
      YROT(N) = A(J,1)*X(N)+A(J,2)*Y(N)+A(J,3)*Z(N)
      XROT(N) = XROT(N)+DELX
      YROT(N) = YROT(N)+DELY
  605 CONTINUE
      XARW = 0.06
      YARW = XARW/3.0
      CALL GARROW(XROT(1),YROT(1),XROT(2),YROT(2),1,XARW,YARW)
  601 CONTINUE
  650 CONTINUE
  520 CONTINUE
  510 CONTINUE
  500 CONTINUE
C
C *** TO PLOT NODE POINT NUMBERS
C
      IF(NOTAT.EQ.1) CALL NDLET(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
      CALL CALPLT(-XORGN,-YORGN,-3)
C
C *** TO MAKE ALL GRID POINT NUMBERS POSITIVE AGAIN
C
      DO 1100 I=1,NNODE
      NUMPT(I)=IABS(NUMPT(I))
 1100 CONTINUE
      RETURN
      END
      SUBROUTINE CURVE(XP,YP,N)
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** THIS SUBROUTINE INTERPOLATES ALONG THE EDGES OF ISOPARAMETRIC
C *** ELEMENTS USING SHAPE FUNCTIONS
C *** CALLED BY PLOTX
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      DIMENSION XP(1),YP(1)
      DIMENSION X(3),Y(3)
      DO 100 I=1,3
         X(I)=XP(I)
```

```
      Y(I)=YP(I)
100   CONTINUE
      R=-1.0
      DO 200 I=1,21
      YP(I)=Y(1)*R*(R-1.0)/2.0-Y(3)*(R+1.0)*(R-1.0)+Y(2)*R*(R+1.0)/2.0
      XP(I)=X(1)*R*(R-1.0)/2.0-X(3)*(R+1.0)*(R-1.0)+X(2)*R*(R+1.0)/2.0
      R=R+0.1
200   CONTINLE
      N=21
      RETURN
      END
      SUBROUTINE DSCALE(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** THIS SUBROUTINE DETERMINES THE SCALE FACTOR FOR DISPLACEMENTS
C *** CALLED BY PSAP1
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KODE
      COMMON/SAVEV/ DMAGS,IDMAG
      COMMON/KOUNT/ NNODE,NNDEST,NUDISP,NVDISP,NWCISP
      DIMENSION NUMPT(1),XPT(1),YPT(1),ZPT(1),UPT(1),VPT(1),WPT(1)
      IF(KDISP.EQ.0.OR.KDISF.EQ.2) GO TO 10
      GO TO (10,20), IDMAG
   10 CONTINUE
      DMAG = DMAGS
      GO TO 30
   20 CONTINUE
      DMAX = 0.0
      DO 100 I=1,NNODE
      IF(NUDISP.EQ.0) GO TC 500
      IF(ABS(UPT(I)).GT.DMAX) DMAX = ABS(UPT(I))
  500 CONTINUE
      IF(NVDISP.EQ.0) GO TC 501
      IF(ABS(VPT(I)).GT.DMAX) DMAX = ABS(VPT(I))
  501 CONTINUE
      IF(NWDISP.EQ.0) GO TC 502
      IF(ABS(WPT(I)).GT.DMAX) DMAX = ABS(WPT(I))
  502 CONTINUE
  100 CONTINUE
      DMAG = DMAGS/DMAX
   30 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE RCTAT
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** SETS UP COEFFICIENTS OF ROTATION MATRIX
C *** CALLED BY FSAP1
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KCCE
      COMMON/ABLK/ A(3,3)
      PI = 3.1415926536
      SINPHI = SIN(PHI*PI/180.0)
      COSPHI = COS(PHI*PI/180.0)
      SINTHE = SIN(THETA*PI/180.0)
      COSTHE = COS(THETA*PI/180.0)
      SINPSI = SIN(PSI*PI/180.0)
      COSPSI = COS(PSI*PI/180.0)
      A(1,1) = COSTHE*COSPSI
      A(1,2) = COSPSI*SINTHE*SINPHI-SINPSI*COSPHI
      A(1,3) = SINTHE*COSPHI*COSPSI+SINPHI*SINPSI
      A(2,1) = SINPSI*COSTHE
      A(2,2) = SINTHE*SINPHI*SINPSI+COSPHI*COSPSI
      A(2,3) = SINTHE*COSPHI*SINPSI-SINPHI*COSPSI
      A(3,1) = -SINTHE
      A(3,2) = COSTHE*SINPHI
      A(3,3) = COSTHE*COSPHI
      RETURN
      END
      SUBROUTINE XYSCAL
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** TO DETERMINE SCALE FACTOR FOR MODEL GEOMETRY.
C *** CALLED BY PLOTX
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KODE
      COMMON/XYZLIM/ XYZMAX(3),XYZMIN(3)
      COMMON/CORGN/ YPMAX,YSPACE,PSIZE
      COMMON/ABLK/ A(3,3)
      COMMON/PDELS/ DELX,DELY
      I = KHORZ
```

```
      J = KVERT
      DMAX = 0.0
      DO 5 N=1,3
      VDUM = ABS(XYZMAX(N)-XYZMIN(N))
      IF(VDUM.GT.DMAX) DMAX = VDUM
    5 CONTINUE
      PSCALE = DMAX/PLOTSZ
      DO 10 L=1,2
      DO 10 M=1,2
      DO 10 N=1,2
      X = XYZMIN(1)
      IF(L.EQ.2) X = XYZMAX(1)
      Y = XYZMIN(2)
      IF(M.EQ.2) Y = XYZMAX(2)
      Z = XYZMIN(3)
      IF(N.EQ.2) Z = XYZMAX(3)
      XROT = A(I,1)*X+A(I,2)*Y+A(I,3)*Z
      YROT = A(J,1)*X+A(J,2)*Y+A(J,3)*Z
      IF(L*M*N.NE.1) GO TO 30
   20 CONTINUE
      XRMIN = XROT
      XRMAX = XROT
      YRMIN = YROT
      YRMAX = YROT
   30 CONTINUE
      IF(XROT.GT.XRMAX) XRMAX = XROT
      IF(XROT.LT.XRMIN) XRMIN = XROT
      IF(YROT.GT.YRMAX) YRMAX = YROT
      IF(YROT.LT.YRMIN) YRMIN = YROT
   10 CONTINUE
      XR=ABS(XRMAX-XRMIN)
      IF(XR/PSCALE.GT.PSIZE) PSCALE=XR/PSIZE
      XRMAX = XRMAX/PSCALE
      YRMAX = YRMAX/PSCALE
      XRMIN = XRMIN/PSCALE
      YRMIN = YRMIN/PSCALE
      DELX = -XRMIN
      DELY = -YRMIN
      XORGN = (PSIZE-XR/PSCALE)/2.0
      YORGN = 0.0
      RETURN
      END
      SUBROUTINE XPLOD(NEND,X,Y,Z,NODE)
C
C *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
C
C *** FOR GENERATING EXPLODED PLOTS.
C *** CALLED BY PLOTX
```

```
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KODE
      DIMENSION X(20),Y(20),Z(20),NODE(20)
C
C *** TO CALCULATE THE INCENTER OF TRIANGLES
C
      IF(NODE(4).EQ.0) NEND=3
      IF(NEND.NE.3) GO TO 20
   10 CONTINUE
      A = SQRT((X(2)-X(3))**2+(Y(2)-Y(3))**2+(Z(2)-Z(3))**2)
      B = SQRT((X(1)-X(3))**2+(Y(1)-Y(3))**2+(Z(1)-Z(3))**2)
      C = SQRT((X(1)-X(2))**2+(Y(1)-Y(2))**2+(Z(1)-Z(2))**2)
      AC1 = A/(A+B+C)
      AC2 = B/(A+B+C)
      AC3 = C/(A+B+C)
      XOC = AC1*X(1)+AC2*X(2)+AC3*X(3)
      YOC = AC1*Y(1)+AC2*Y(2)+AC3*Y(3)
      ZOC = AC1*Z(1)+AC2*Z(2)+AC3*Z(3)
      GO TO 190
   20 CONTINUE
C
C *** TO CALCULATE THE CENTROID OF RODS,BARS,AND QUADS
C
      XOC = 0.0
      YOC = 0.0
      ZOC = 0.0
      FND=0.0
      DO 100 I=1,NEND
      IF(NODE(I).EQ.0) GO TO 100
      IF(I.GT.8) GO TO 101
      FND=FND+1.0
      XOC = XOC+X(I)
      YOC = YOC+Y(I)
      ZOC = ZOC+Z(I)
  100 CONTINUE
  101 CONTINUE
      XOC=XOC/FND
      YOC=YOC/FND
      ZOC=ZOC/FND
  190 CONTINUE
C
C *** TO REDUCE THE SIZE OF THE ELEMENT
C
      DO 200 I=1,NEND
```

```
      IF(NODE(I).EQ.0) GO TO 200
      X(I) = X(I)*DMAG
      Y(I) = Y(I)*DMAG
      Z(I) = Z(I)*DMAG
  200 CONTINUE
C
C *** TO CALCULATE THE CENTROID OF THE REDUCED ELEMENT
C
      XRC = XOC*DMAG
      YRC = YOC*DMAG
      ZRC = ZOC*DMAG
C
C *** SHIFT CORNERS OF ORIGINAL AND REDUCED TO MAKE CENTROIDS MATCH
C
      DO 400 I=1,NEND
      IF(NODE(I).EQ.0) GO TO 400
      X(I) = X(I)+(XOC-XRC)
      Y(I) = Y(I)+(YOC-YRC)
      Z(I) = Z(I)+(ZOC-ZRC)
  400 CONTINUE
      RETURN
      END
      SUBROUTINE GARROW(X1,Y1,X2,Y2,NC,XHEAD,YHEAD)
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** TO DRAW ARROWS FROM X1,Y1 TO X2,Y2.
C *** CALLED BY PLOTX
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      DEN = SQRT((X2-X1)**2+(Y2-Y1)**2)
      IF(DEN.EQ.0.0) GO TO 5000
      C = (X1-X2)/DEN
      S = (Y1-Y2)/DEN
      CALL CALPLT(X1,Y1,3)
      CALL CALPLT(X2,Y2,2)
      IF(NC.LT.1) GO TO 1000
      XA = X2+(C*XHEAD-S*YHEAD)
      YA = Y2+(S*XHEAD+C*YHEAD)
      CALL CALPLT(XA,YA,2)
      IF(NC.LT.2) GO TO 1000
      XB = X2+(C*XHEAD-S*(-YHEAD))
      YB = Y2+(S*XHEAD+C*(-YHEAD))
      CALL CALPLT(XB,YB,2)
      IF(NC.LT.3) GO TO 1000
      CALL CALPLT(X2,Y2,2)
      IF(NC.LT.4) GO TO 1000
```

```
      XC = X2+(-S*YHEAD)
      YC = Y2+(+C*YHEAD)
      CALL CALPLT(XC,YC,2)
      IF(NC.LT.5) GO TO 1000
      XD = X2+(-S*(-YHEAD))
      YD = Y2+(+C*(-YHEAD))
      CALL CALPLT(XD,YD,2)
 1000 CONTINUE
      CALL CALPLT(X2,Y2,3)
 5000 CONTINUE
      RETURN
      END
      SUBROUTINE NDLET(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** FOR ANNOTATING GRID POINT NUMBERS ON PLOTS.
C *** CALLED BY PSAP1
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISF,DMAG,KODE
      COMMON/LIMITS/ XXMAX,YYMAX,ZZMAX,XXMIN,YYMIN,ZZMIN,NDMAX,NDMIN,
     1NELMAX,NELMIN
      COMMON/XYZLIM/ XYZMAX(3),XYZMIN(3)
      COMMON/ABLK/ A(3,3)
      COMMON/KOUNT/ NNODE,NNDEST,NUDISP,NVDISP,NWDISP
      COMMON/PDELS/ DELX,DELY
      DIMENSION NUMPT(1),XPT(1),YPT(1),ZPT(1),UPT(1),VPT(1),WPT(1)
      II = KHORZ
      JJ = KVERT
      XSHIFT = 0.0
      YSHIFT = 0.0
      ZSHIFT = 0.0
      DO 500 I=1,NNODE
      IF(NUMPT(I).LE.0) GO TO 500
      IF(NUMPT(I).LT.NDMIN.OR.NUMPT(I).GT.NDMAX) GO TO 500
      IF(XPT(I).GT.XYZMAX(1)) GO TO 500
      IF(XPT(I).LT.XYZMIN(1)) GO TO 500
      IF(YPT(I).GT.XYZMAX(2)) GO TO 500
      IF(YPT(I).LT.XYZMIN(2)) GO TO 500
      IF(ZPT(I).GT.XYZMAX(3)) GO TO 500
      IF(ZPT(I).LT.XYZMIN(3)) GO TO 500
      X = (XPT(I)+XSHIFT)/PSCALE
      Y = (YPT(I)+YSHIFT)/PSCALE
      Z = (ZPT(I)+ZSHIFT)/PSCALE
```

```
      XROT = A(II,1)*X+A(II,2)*Y+A(II,3)*Z
      YROT = A(JJ,1)*X+A(JJ,2)*Y+A(JJ,3)*Z
      XL = XROT+XLHT/2.0
      YL = YROT+XLHT/2.0
      XL = XL+DELX
      YL = YL+DELY
      AL = NUMPT(I)
      CALL NUMBER(XL,YL,XLHT,AL,0.0,-1)
  500 CONTINUE
      RETURN
      END
      SUBROUTINE NFRAME
C *** CALLED BY PLOTX
      RETURN
      END
      SUBROUTINE CCRT2
      RETURN
      END
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C ***** ADAPT FOR NPS SYSTEM
C *** CALLED BY PSAP1
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
      SUBROUTINE CALCMP
      COMMON/PLOTC/ IBUFF(1024)
      CALL PLOTS
      RETURN
      END
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C **** ADAPT FOR NPS SYSTEM
C *** CALLED BY PSAP1/PLOTX/GARROW/ERROR
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      SUBROUTINE CALPLT(X,Y,IPEN)
      CALL PLOT(X,Y,IPEN)
      RETURN
      END
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C**** ADAPT FOR NPS SYSTEM
C *** CALLED BY PSAP1
C
```

```
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      SUBROUTINE NOTATE(X,Y,HT,BCD,THETA,N)
      DIMENSION BCD(1)
      CALL SYMBOL(X,Y,HT,BCD,THETA,N)
      RETURN
      END
      SUBROUTINE ELTYPE(MTYPE,KGEOM)
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C
C ***THIS SUBROUTINE CALLS CTHER ROUTINES TO READ ELEMENT CONNECTIVITY
C *** MTYPE = ELEMENT TYPE
C *** KGEOM = 1     -     ACINA ELEMENTS
C *** KGEOM = 2     -     NONSAP ELEMENTS
C *** KGEOM = 9     -     SAP IV ELEMENTS
C *** CALLED BY GEOM1/GEOM2/GEOM9/
C
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      IF(KGEOM.EQ.1) GO TC 20
      IF(KGEOM.EC.2) GO TO 40
      GO TO (1,2,3,4,5,6,7,8,9,10,11,12),MTYPE
    1 CALL TRUSS
      GO TO 900
    2 CALL BEAM
      GO TO 900
    3 CALL PLANE
      GO TO 900
    4 CALL PLANE
      GO TO 900
    5 CALL THREED
      GO TO 900
    6 CALL SHELL
      GO TO 900
    7 CALL BNDRY
      GO TO 900
    8 CALL SOL21
      GO TO 900
    9 CALL ERROR(1)
      GO TO 900
   10 CALL ERROR(1)
      GO TO 900
   11 CALL ERROR(1)
      GO TO 900
   12 CALL ERROR(1)
```

```
      GO TO 900
   20 CONTINUE
      GO TO (21,22,23,24),MTYPE
   21 CALL ADTRUS
      GO TO 900
   22 CALL ADPLAN
      GO TO 900
   23 CALL AD3DEE
      GO TO 900
   24 CALL ADBEAM
      GO TO 900
   40 CONTINUE
      GO TO (41,42,43),MTYPE
   41 CALL NSTRUS
      GO TO 900
   42 CALL NSPLAN
      GO TO 900
   43 CALL NS3DEE
  900 RETURN
      END
      SUBROUTINE FRROR(N)
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** THIS SUBROUTINE TERMINATES THE PROGRAM DUE TO ERROR IN INPUT.
C *** ERROR ALSO ZEROS AND ADVANCES THE CALCOMP PLOTTER
C *** CALLED BY ELTYPE/PSAP1/INITAL/PLOTX/THREED/SOL21/ADTRUS/ADPLAN/
C *** AD3DEE/ADBEAM/NSTRUS/NSPLAN/NS3DEE/GEOM2/
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/CORGN/ YPMAX,YSPACE,PSIZE
      CALL CALPLT(0.0,YPMAX+6.0,-3)
      GO TO(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20),N
    1 CONTINUE
      WRITE(6,9001)
 9001 FORMAT(///,1X,'TERMINATION OCCURRED IN SUBROUTINE ELTYPE   ELEMENT
     1 IN INPUT DATA CANNOT BE PLOTTED  CHECK ELEMENT TYPES'///)
      GO TO 1000
    2 CONTINUE
      WRITE(6,9002)
 9002 FORMAT(///,1X,'ABNORMAL TERMINATION OCCURRED IN SUBROUTINE PSAP1 C
     1HECK VALUE OF KODE IN NAMELIST PICT'///)
      GO TO 1000
    3 CONTINUE
      WRITE(6,9003)
 9003 FORMAT(///,1X,'ABNORMAL TERMINATION OCCURRED IN SUBROUTINE INITAL
     1- ATTEMPT TO READ NAMELIST OPTION'///)
```

```
      GO TO 1000
    4 CONTINUE
      WRITE(6,9004)
 9004 FORMAT(//,1X,'ABNORMAL TERMINATION OCCURRED IN PLOTX'//)
      GO TO 1000
    5 CONTINUE
      WRITE(6,9005)
 9005 FORMAT(//,'ABNORMAL TERMINATION IN THREED,ELEMENT CARD ERROR'//)
      GO TO 1000
    6 CONTINUE
      WRITE(6,9006)
 9006 FORMAT(//,'ABNORMAL TERMINATION IN SOL21 ,ELEMENT CARD ERROR'//)
      GO TO 1000
    7 CONTINUE
      WRITE(6,9007)
 9007 FORMAT(//,'ABNORMAL TERMINATION IN ADTRUS,ELEMENT CARD ERROR'//)
      GO TO 1000
    8 CONTINUE
      WRITE(6,9008)
 9008 FORMAT(//,'ABNORMAL TERMINATION IN ADPLAN,ELEMENT CARD ERROR'//)
      GO TO 1000
    9 CONTINUE
      WRITE(6,9009)
 9009 FORMAT(//,'ABNORMAL TERMINATION IN AD3DEE,ELEMENT CARD ERROR'//)
      GO TO 1000
   10 CONTINUE
      WRITE(6,9010)
 9010 FORMAT(//,'ABNORMAL TERMINATION IN ADBEAM,ELEMENT CARD ERROR'//)
      GO TO 1000
   11 CONTINUE
      WRITE(6,9011)
 9011 FORMAT(//,'ABNORMAL TERMINATION IN NSTRUS,ELEMENT CARD ERROR'//)
      GO TO 1000
   12 CONTINUE
      WRITE(6,9012)
 9012 FORMAT(//,'ABNORMAL TERMINATION IN NSPLAN,ELEMENT CARD ERROR'//)
      GO TO 1000
   13 CONTINUE
      WRITE(6,9013)
 9013 FORMAT(//,'ABNORMAL TERMINATION IN NS3DEE,ELEMENT CARD ERROR'//)
      GO TO 1000
   14 CONTINUE
      WRITE(6,9014)
 9014 FORMAT(//,' ABNORMAL TERMINATION NONSAP MESH CANNOT BE PLOTTED'//)
      GO TO 1000
   15 CONTINUE
      GO TO 1000
   16 CONTINUE
```

```
      GO TO 1000
   17 CONTINUE
      GO TO 1000
   18 CONTINUE
      GO TO 1000
   19 CONTINUE
      GO TO 1000
   20 CONTINUE
 1000 CONTINUE
      CALL PSTOP
      RETURN
      END
      SUBROUTINE GEOM9(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C *** GEOM9 READS SAP IV GEOMETRY DATA
C *** CALLED BY PSAP1
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KODE
      COMMON/KOUNT/ NNODE,NNDEST,NUDISP,NVDISP,NWDISP
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      DIMENSION NUMPT(1),XPT(1),YPT(1),ZPT(1),UPT(1),VPT(1),WPT(1)
      DATA CTEST/'C    '/
C
C *** INSERT ROUTINE HERE
C
      READ(5,100) HED
  100 FORMAT(12A6)
C
C
C *** READ MASTER CONTROL CARD
C *** NUMNP = TOTAL NUMBER OF NODE POINTS
C *** NELTYP = NUMBER OF ELEMENT GROUPS
C
C
      READ(5,200)NUMNP,NELTYP
  200 FORMAT(2I5)
      NNODE=NUMNP
C
C*********READ OR GENERATE NODAL POINT DATA
C
      NOLD=0
   10 READ(5,9006) CT,N,XPT(N),YPT(N),ZPT(N),KN
```

```
 9006 FORMAT(A1,I4,30X,3F10.0,I5)
C
C ***CHECK FOR CYLINDRICAL COORDINATES
C
      IF(CT.NE.CTEST) GO TC 20
          R=XPT(N)
          XPT(N)=R*SIN(ZPT(N)/57.2958)
          ZPT(N)=R*COS(ZPT(N)/57.2958)
   20 CONTINUE
      NUMPT(N)=N
      IF (NOLD.EQ.0) GO TO 50
C
C*********CHECK IF GENERATICN IS REQUIRED
C
      IF (KN.EQ.0) GO TO 50
      NUM=(N-NOLD)/KN
      NUMN=NUM-1
      IF(NUMN.LT.1) GO TO 50
      XNUM=NUM
      DX=(XPT(N)-XPT(NOLD))/XNUM
      DY=(YPT(N)-YPT(NOLD))/XNUM
      DZ=(ZPT(N)-ZPT(NOLD))/XNUM
      K=NOLD
      DO 30 J=1,NUMN
      KK=K
      K=K+KN
      XPT(K)=XPT(KK)+DX
      YPT(K)=YPT(KK)+DY
      ZPT(K)=ZPT(KK)+DZ
      NUMPT(K)=K
   30 CONTINUE
   50 NOLD=N
      IF(N.NE.NUMNP) GO TO 10
      NUMEL=0
C********* READ ELEMENT CCNTROL CARDS
      DO 900 M=1,NELTYP
      READ(5,1001,END=999) (NPAR(I),I=1,14)
 1001 FORMAT(14I5)
      WRITE(6,9010) (NPAR(I),I=1,14)
 9010 FORMAT(///,'  NPAR = ',20I5///)
      MTYPE=NPAR(1)
      CALL ELTYPE(MTYPE,KGEOM)
  900 CONTINUE
      ENDFILE 10
  999 RETURN
      END
      SUBROUTINE TRUSS
C
```

```
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C *** READS SAP IV TRUSS ELEMENT CARDS (ELTYPE 1)
C
C *** CALLED BY ELTYPE
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      N2=2
      NUME=NPAR(2)
      NUMMAT=NPAR(3)
C ****  READ MATERIAL PROPERTY CARDS (DUMMY)
      DO 10 I=1,NUMMAT
      READ(5,1001) DUMMY
 1001 FORMAT(10A8)
   10 CONTINUE
C ***** READ ELEMENT LOAD MUL. (DUMMY1)
      DO 20 I=1,4
      READ(5,1001) DUMMY1
   20 CONTINUE
      IF(NPAR(14).EQ.0) NPAR(14) = 1
      N= NPAR(14)
C *** READ ELEMENT CONNECTION INFORMATION OR GENERATE
  100 READ(5,1004) M,II,JJ,MTYP,TEM,KK
 1004 FORMAT(4I5,F10.0,I5)
      IF(KK.EQ.0) KK=1
  120 IF (M.NE.N) GO TO 200
      I=II
      J=JJ
      KKK=KK
  200 CONTINUE
      NUMEL=NUMEL+1
      WRITE(10) N2,N,I,J
      IF(N.EQ.NUME) RETURN
      N=N+1
      I=I+KKK
      J=J+KKK
      IF(N.GT.M) GO TO 100
      GO TO 120
      END
      SUBROUTINE PLANE
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C *** READS SAP IV MEMBRANE ELEMENT CARDS (ELTYPE 3)
C *** CALLED BY ELTYPE
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
```

```
C
      DIMENSION  EMUL(4,5),IE(5),IX(4)
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      N4=4
      NUME= NPAR(2)
      NUMMAT= NPAR(3)
C ****  READ MATERIAL PROPERTIES
      DO 60 M=1,NUMMAT
      READ(5,1010) MAT,NT
 1010 FORMAT(2I5)
      IF(NT.EQ.0) NT=1
      NTC=2* NT
      DO 50 K=1,NTC
      READ(5,1005) DUMMY
 1005 FORMAT (10A8)
   50 CONTINUE
   60 CONTINUE
C
C****  READ ELEMENT LOAD FACTORS
C
      READ(5,1002) ((EMUL(I,J),J=1,5),I=1,4)
 1002 FORMAT(5F10.0)
C
C****  READ ELEMENT PROPERTIES
C
      IF(NPAR(14).EQ.0) NPAR(14) = 1
      N=NPAR(14)-1
  130 READ(5,1003) M,(IE(I),I=1,4),KG
 1003 FORMAT(5I5,30X,I5)
      IF(KG.EQ.0) KG=1
  140 N=N+1
      IF(M.EQ.N) GO TO 145
      DO 142 I=1,4
  142 IX(I)=IX(I)+KG
      GO TO 150
  145 DO 148 I=1,4
  148 IX(I)=IE(I)
  150 CONTINUE
      I = IX(1)
      J = IX(2)
      K = IX(3)
      L = IX(4)
      NUMEL=NUMEL+1
      WRITE(10) N4,N,I,J,K,L
  310 IF(N.EQ.NUME) RETURN
      IF(N.EC.M) GO TO 130
      GO TO 140
      END
```

```
      SUBROUTINE BEAM
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** READS SAP IV BEAM ELEMENT CARDS (ELTYPE 2)
C *** CALLED BY ELTYPE
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      N2=2
      NUME=NPAR(2)
      NUMEPC=NPAR(3)
      NUMFEF=NPAR(4) * 2
      NUMMAT=NPAR(5)
C ***  READ MATERIAL PROPERTY CARDS (DUMMY)
      DO 10  I=1,NUMMAT
      READ(5,1001) DUMMY
 1001 FORMAT(10A8)
   1C CONTINLE
C ***  READ ELEMENT PROPERTY CARDS (DUMMY1)
      DO 20  J=1,NUMEPC
      READ (5,1001) DUMMY1
   20 CONTINUE
C ***  READ ELEMENT LOAD MULTIPLIERS(DUMMY2)
      DO 30 K=1,3
      READ (5,1001) DUMMY2
   30 CONTINUE
C ***  READ  FIXED-END FORCE CARDS(DUMMY3)
      DO 40 L=1,NUMFEF
      READ(5,1001) DUMMY3
   40 CONTINUE
      IF(NPAR(14).EQ.0) NPAR(14) = 1
      N=NPAR(14)
C ***  READ ELEMENT CONNECTION  INFO
  100 READ(5,10C2) M,II,JJ ,KK
 1002 FORMAT(3I5,47X,I8)
      IF (KK.EQ.0) KK=1
  12C IF (M.NE.N) GO TO 200
      I = II
      J = JJ
      KKK = KK
  200 CONTINUE
      NUMEL = NUMEL+1
      WRITE(10) N2,N,I,J
      IF (N.EQ.NUME) RETURN
      N = N + 1
      I = I + KKK
```

```
      J = J + KKK
      IF (N.GT.M) GO TO 100
      GO TO 120
      END
      SUBROUTINE THREED
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** THIS SUBROUTINE READS SAP IV 3-D 8 NODE BRICK ELEMENTS
C *** CALLED BY ELTYPE
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      DIMENSION INP(8),NP(8)
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      N8=8
      NUME=NPAR(2)
      NUMMAT=NPAR(3)
      NDISLD=NPAR(4)
C *** READ THE MATERIAL PROPERTIES
      DO 50 M=1,NUMMAT
         READ(5,9002) DUMMY
 9002 FORMAT(20A4)
   50    CONTINUE
C *** READ DISTRIBUTED SURFACE LOADS
      IF(NDISLD.EQ.0) GO TO 61
      DO 60 M=1,NDISLD
         READ(5,9002) DUMMY
   60    CONTINUE
   61 CONTINUE
C *** READ ACCELERATION DUE TO GRAVITY
      READ(5,9002) DUMMY
C *** READ ELEMENT LOAD CASE MULTIPLIERS
      DO 80 I=1,5
         READ(5,9002) DUMMY
   80 CONTINUE
      IF(NPAR(14).EQ.0) NPAR(14)=1
      NEL=NPAR(14)-1
  130 READ(5,9006) INEL,(INP(I),I=1,8),ININT,IMAT,IINC
 9006 FORMAT(12I5)
      IF(IINC.EQ.0) IINC=1
  140 NEL=NEL+1
      ML=INEL-NEL
      IF(ML)150,155,160
  150 CALL ERROR(5)
C *** NO GENERATION OF NODE POINTS REQUIRED
  155 DO 156 I=1,8
         NP(I)=INP(I)
```

```
  156       CONTINUE
      GO TO 162
C *** GENERATICN REQUIRED
  160 CO 161 I=1,8
          NP(I)=NP(I)+IINC
  161     CONTINUE
  162 CONTINUE
      NUMEL=NUMEL+1
      WRITE(10) N8,NEL,(NP(I),I =1,8)
      IF(NEL.EQ.NUME) RETURN
      IF(NEL.EQ.INEL) GC TC 130
      GO TO 140
      END
      SUBROUTINE SHELL
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** READS SAP IV SHELL ELEMENT CARDS (ELTYPE 6)
C *** CALLED BY ELTYPE
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      DIMENSION IY(7),IX(4)
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      N4=4
      ISTOP=0
      NUME = NPAR(2)
      NUMMAT = NPAR(3)
      NMAT= 2*NUMMAT
C *** READ MATERIAL PROPERTIES (DUMMY)
      DO 10 N=1,NMAT
      READ(5,1000) DUMMY
C
 1000 FORMAT(10A8)
   10 CONTINUE
C **** READ ELEMENT LOAD FACTORS (DUMMY1)
      CO 20 K=1,5
      READ(5,1000) DUMMY1
   20 CONTINUE
      IF(NPAR(14).EQ.0) NPAR(14) = 1
      NN = NPAR(14)-1
  100 READ(5,1001) MM,IY
 1001 FORMAT(8I5)
  110 NN = NN + 1
      IF (MM -NN) 440,50,6C
   50 DO 45  I=1,7
   45 IX(I) = IY(I)
      INCL = IY(7)
```

```
      IF (INCL.EQ.0)  INCL=1
      GO TO 70
   60 DO 65  I=1,4
   65 IX(I)= IX(I) + INCL
   70 CONTINUE
      I=IX(1)
      J= IX(2)
      K=IX(3)
      L=IX(4)
      NUMEL = NUMEL +1
      WRITE(10) N4,NN,I,J,K,L
      GO TO 500
  440 WRITE (6,2005) MM
 2005 FORMAT(19HOCARD FOR ELEMT(,I5,14H) IS IN ERROR.,1X)
      ISTOP = 1
  500 IF(NN.LT.MM) GO TO 110
      IF(NN.EQ.NUME) RETURN
      IF(ISTOP.EQ.1) STOP
      GO TO 100
      END
      SUBROUTINE BNDRY
C
C *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *
C
C *** READS SAP IV BOUNDARY ELEMENT CARDS (ELTYPE 7)
C *** BOUNDARY ELEMENTS ARE NOT PLOTTED
C *** CALLED BY ELTYPE
C
C *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *
C
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      NUME=NPAR(2)
C *** READ LOAD CASE CARD (DUMMY)
      READ(5,1002) DUMMY
 1002 FORMAT(10A8)
C *** READ BOUNDARY ELEMENT CARDS
      N=0
  100 READ(5,1004) M,II,KK
      N=N+1
      IF(N.GE.NUME) RETURN
      IF(KK.GT.0) GO TO 200
      GO TO 100
  200 READ(5,1004) M2,II2,KK2
      N=N+(M2-M)/KK
      IF(N.GE.NUME) RETURN
      GO TO 100
 1004 FORMAT(2I5,25X,I5)
      END
```

```
      SUBROUTINE SOL21
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C *** THIS SUBROUTINE READS SAP IV 3-D,8-20 NODE BRICK ELEMENTS
C *** CALLED BY ELTYPE
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      DIMENSION NP(20),INP(20)
      COMMON/GCONT/NUMNP,NFAR(20),NELTYP,NUMEL
      N20=20
      NSOL21=NPAR(2)
      NUMMAT=NPAR(3)
      MAXTP=NPAR(4)
      IF(MAXTP.EQ.0) MAXTP=1
      NORTHO=NPAR(5)
      NDLS=NPAR(6)
      MAXNOD=NPAR(7)
      IF(MAXNOD.EQ.0) MAXNGD=21
      IF(MAXNOD.EQ.8) N20=8
      NOPSET=NPAR(8)
C *** READ THE MATERIAL PROPERTY CARDS
      DO 50 J=1,NUMMAT
         READ(5,9002) M,NTF
 9002 FORMAT(2I5)
         IF(NTP.EQ.0) NTP=1
         NTP2=2*NTP
         DO 40 JJ=1,NTP2
            READ(5,9004) DUMMY
 9004 FORMAT(20A4)
   40       CONTINUE
   5C    CONTINUE
C *** READ MATERIAL AXES ORIENTATION SETS
      IF(NORTHO.EQ.0) GO TC 61
      DO 60 J=1,NORTHO
         READ(5,9004) DUMMY
   60    CONTINLE
   61 CONTINUE
C *** READ DISTRIBUTED SURFACE LOAD DATA
      IF(NDLS.EQ.0) GO TC 71
      NDLS2=NDLS*2
      DO 70 J=1,NDLS2
         READ(5,9004) DUMMY
   70    CONTINUE
   71 CONTINUE
C *** READ STRESS OUTPUT LOCATION SETS
      IF(NOPSET.EC.0) GC TC 81
```

```
      DO 80 J=1,NOPSET
         READ(5,9004) DUMMY
   80    CONTINUE
   81 CONTINUE
C *** READ ELEMENT LOAD CASE MULTIPLIERS
      DO 90 J=1,5
         READ(5,9004) DUMMY
   90    CONTINUE
C *** READ ELEMENT DATA CARDS
      IF(NPAR(14).EQ.0) NPAR(14)=1
      NEL=NPAR(14)-1
  130 READ(5,9006) INEL,IINC
 9006 FORMAT(I5,35X,I5)
      READ(5,9008) (INP(I),I=1,N20)
 9008 FORMAT(16I5)
      IF(IINC.EQ.0) IINC=1
  140 NEL=NEL+1
      ML=INEL-NEL
      IF(ML) 150,155,160
  150 CALL ERROR(6)
C *** NO GENERATION OF NODE POINTS REQUIRED
  155 DO 156 I=1,N20
         NP(I)=INP(I)
  156    CONTINUE
      GO TO 162
C *** GENERATION OF NODE POINTS REQUIRED
  160 DO 161 I=1,N20
         IF(NP(I).EQ.0) GO TO 161
         NP(I)=NP(I)+KN
  161    CONTINUE
  162 CONTINUE
      NUMEL=NUMEL+1
      WRITE(10) N20,NEL,(NP(I),I=1,N20)
      IF(NEL.EQ.NSOL21) RETURN
      IF(NEL.LT.INEL) GO TO 140
      KN=IINC
      GO TO 130
      END
      SUBROUTINE GEOM1(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** THIS ROUTINE READS ADINA DATA CARDS FROM THE TITLE CARD TO THE
C *** ELEMENT CONTROL CARDS - IT IS CALLED BY PSAP1
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
```

```
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KCDE
      COMMON/KOUNT/ NNODE,NNCEST,NUDISP,NVDISP,NWCISP
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      DIMENSION NUMPT(1),XPT(1),YPT(1),ZPT(1),UPT(1),VPT(1),WPT(1)
      DIMENSION IDOF(6),ID(6),IDOLD(6)
     1,NODE(20)
      DATA CTEST/'X   '/
      NCARD=0
      READ(5,9000) DUMMY
 9000 FORMAT(20A4)
C *** READ MASTER CONTROL CARDS
C *** NUMNP = TOTAL NUMBER OF NODE POINTS
C *** NELTYP = NUMBER OF ELEMENT GROUPS
      READ(5,9001) NUMNP,(IDOF(I),I=1,6),NEGL,NEGNL,MODEX,NSTE
 9001 FORMAT(I5,6I1,I4,3I5)
      NELTYP=NEGL+NEGNL
      NNODE=NUMNP
      READ(5,9002) IMASS,IDAMP,IMASSN,IDAMPN
 9002 FORMAT(4I5)
      READ(5,9002) IEIG
      READ(5,9002) ISREF,NUMREF,IEQUIT,ITEMAX
      READ(5,9000) DUMMY
      READ(5,9000) DUMMY
      READ(5,9000) DUMMY
C *** READ OR GENERATE NODAL POINT DATA
      NOLD=0
      NEQ=0
   10 READ(5,9006)CT,N,(ID(I),I=1,6),XPT(N),YPT(N),ZPT(N),KN
 9006 FORMAT(A1,I4,1X,I4,5I5,3F10.0,I5)
C *** CHECK FOR CYLINDRICAL COORDINATES
      IF(CT.NE.CTEST) GO TC 12
         DUM=ZPT(N)/57.2958
         R=YPT(N)
         YPT(N)=R*COS(ZPT(N)/57.2958)
         ZPT(N)=R*SIN(ZPT(N)/57.2958)
   12 CONTINUE
      NUMPT(N)=N
      IF(NOLD.EQ.0) GO TO 50
C *** FOR GENERATION OF FIXED BOUNDARY CONDITIONS
      DO 15 I=1,6
      IF(ICOLD(I).EQ.-1.AND.ID(I).EQ.0) ID(I)=IDOLD(I)
   15    CONTINUE
      IF(KNOLD.EQ.0) GO TO 5C
      NUM=(N-NOLD)/KNOLD
      NUMN=NUM-1
      IF(NUMN.LT.1) GO TO 50
C *** TO COUNT DOFS TO DETERMINE NUMBER OF IC CARCS
```

```
      DO 20 I=1,6
         IF(IDOF(I).EQ.0.AND.IDOLD(I).EQ.0) NEQ=NEQ+NUMN
   20 CONTINUE
      DX=(XPT(N)-XPT(NOLD))/NUM
      IF(CT.NE.CTEST) GO TO 21
      ROLD=YPT(NOLD)/COS(DUMOLD)
      RNEW=YPT(N)/COS(DUM)
      DR=(RNEW-ROLD)/NUM
      DT=(DUM-DUMOLD)/NUM
      GO TO 22
   21 CONTINUE
      DY=(YPT(N)-YPT(NOLD))/NUM
      DZ=(ZPT(N)-ZPT(NOLD))/NUM
   22 CONTINUE
      K=NOLD
      DO 30 J=1,NUMN
         KK=K
         K=K+KNOLD
         XPT(K)=XPT(KK)+DX
          IF(CT.NE.CTEST) GO TO 26
          ROLD=ROLD+DR
          DUMOLD=DUMOLD+DT
          YPT(K)=ROLD*COS(DUMOLD)
          ZPT(K)=ROLD*SIN(DUMOLD)
          GO TO 28
   26     CONTINUE
         YPT(K)=YPT(KK)+DY
         ZPT(K)=ZPT(KK)+DZ
   28     CONTINUE
         NUMPT(K)=K
   30    CONTINUE
   50 NOLD=N
      KNOLD=KN
      DUMOLD=DUM
C *** TO COUNT DOFS TO DETERMINE NUMBER OF IC CARDS
      DO 55 I=1,6
         IF(IDOF(I).EQ.0.AND.ID(I).EQ.0) NEQ=NEQ+1
         IDOLD(I)=ID(I)
   55    CONTINUE
      IF(N.NE.NUMNP) GO TO 10
C *** READ LOAD CONTROL CARDS
      READ(5,9000) DUMMY
      DO 80 I=1,IMASSN
      IF(IMASSN.EQ.0) GO TO 81
         READ(5,9000) DUMMY
   80    CONTINUE
   81 CONTINUE
      IF(ICAMPN.EQ.0) GO TO 91
```

```
      DO 90 I=1,IDAMPN
         READ(5,9000) DUMMY
   90    CONTINUE
   91 CONTINUE
C *** READ INITIAL CONDITIONS
      READ(5,9002) ICON
      IF(ICON.EQ.0) GO TO 100
      CARDNR=NEQ/6.0
      NCARD=INT(CARDNR)
      TEST=CARDNR-NCARD
      IF(TEST.GT.0.1) NCARD=NCARD+1
      DO 95 I=1,NCARD
         READ(5,9000) DUMMY
   95    CONTINUE
      IF(IMASS.EQ.0) GO TO 100
      DO 96 I=1,NCARD
         READ(5,9000) DUMMY
   96    CONTINUE
      DO 98 I=1,NCARD
         READ(5,9000) DUMMY
   98    CONTINUE
 9007 FORMAT(6E12.6)
  100 CONTINUE
      NUMEL=0
      WRITE(6,9009) NEQ,NCARD
 9009 FORMAT(///,' NEQ AND NCARD FOR IC IN GEOM1  = ',I5,10X,I5///)
C *** READ ELEMENT CONTROL CARDS
      DO 900 M=1,NELTYP
         READ(5,9008,END=999)(NPAR(I),I=1,20)
      WRITE(6,9010) (NPAR(I),I=1,20)
 9008 FORMAT(20I4)
 9010 FORMAT(///,'  NPAR = ',20I5///)
         MTYPE=NPAR(1)
         CALL ELTYPE(MTYPE,KGEOM)
  900    CONTINUE
      ENDFILE 10
  999 RETURN
      END
      SUBROUTINE ADTRUS
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** THIS SUBROUTINE TO READ ADINA TRUSS DATA
C *** THIS ROUTINE CALLED BY ELTYPE
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
```

```
      NUMMAT=NPAR(16)
      N2=2
      IF(NUMMAT.EQ.0) NUMMAT=1
      IF(NPAR(15).EQ.1) NCARD=2
      IF(NPAR(15).EQ.3) NCARD=3
      IF(NPAR(15).NE.2) GO TO 20
      CARDNR=NPAR(17)/8.0
      NCARD=INT(CARDNR)
      TEST=CARDNR-NCARD
      IF(TEST.GT.0.1) NCARD=NCARD+1
      NCARD=NCARD+2
   20 CONTINUE
C *** READ MATERIAL PROPERTIES
      DO 50 J=1,NUMMAT
           DO 45 I=1,NCARD
                READ(5,9000) DUMMY
 9000 FORMAT(20A4)
   45           CONTINUE
   50      CONTINUE
C *** READ OR GENERATE ELEMENT DATA CARDS
      IF(NPAR(14).EQ.0) NPAR(14)=1
      NEL=NPAR(14)-1
  130 READ(5,9002) INEL,II,JJ,IINC
 9002 FORMAT(3I5,20X,I5)
      IF(IINC.EQ.0) IINC=1
  140 NEL=NEL+1
      ML=INEL-NEL
      IF(ML) 150,155,160
  150 CALL ERROR(7)
C *** NO GENERATION OF NODE POINTS REQUIRED
  155 I=II
      J=JJ
      GO TO 162
C *** GENERATION OF NODE POINTS REQUIRED
  160 I=I+KN
      J=J+KN
  162 CONTINUE
      NUMEL=NUMEL+1
      WRITE(10) N2,NEL,I,J
      IF(NEL.EQ.NPAR(2)) RETURN
      IF(NEL.LT.INEL) GO TO 140
      KN=IINC
      GO TO 130
      END
      SUBROUTINE ADPLAN
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      DIMENSION NP(12),INP(8)
C
```

```
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
C *** THIS SUBROUTINE TO READ ADINA 8-NODE PLANE ELEMENT DATA
C *** IT IS CALLED BY ELTYPE
C
C
C *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *    *
C
      NUMMAT=NPAR(16)
      NSTRES=NPAR(13)
C *** CALCULATE THE NUMBER OF MATERIAL CASE CARDS
      IF(NPAR(15).EQ. 1) NCARD=1
      IF(NPAR(15).EQ. 2) NCARD=1
      IF(NPAR(15).EQ. 3) NCARD=4
      IF(NPAR(15).EQ. 4) NCARD=4
      IF(NPAR(15).EQ. 5) NCARD=2
      IF(NPAR(15).EQ. 7) NCARD=1
      IF(NPAR(15).EQ. 8) NCARD=1
      IF(NPAR(15).EQ. 9) NCARD=1
      IF(NPAR(15).EQ.10) NCARD=6
      IF(NPAR(15).EQ.11) NCARD=6
      IF(NPAR(15).EQ.13) NCARD=1
      IF(NPAR(15).NE.14)   GO TO 20
      CARDNR=NPAR(17)/8.0
      NCARD=INT(CARDNR)
      TEST=CARDNR-NCARD
      IF(TEST.GT.0.1) NCARD=NCARD+1
   20 CONTINUE
      N12=12
C *** READ MATERIAL PROPERTIES
      DO 50 J=1,NUMMAT
         READ(5,9000) DUMMY
 9000 FORMAT(20A4)
         DO 45 I=1,NCARD
            READ(5,9000) DUMMY
   45          CONTINUE
   50    CONTINUE
C *** READ STRESS OUTPUT TABLE CARDS
      IF(NPAR(13).EQ.0) GO TO 61
      DO 60 I=1,NSTRES
         READ(5,9000)DUMMY
   60    CONTINUE
   61 CONTINUE
C *** READ AND GENERATE ELEMENT DATA CARDS
      IF(NPAR(14).EQ.0) NPAR(14)=1
      NEL=NPAR(14)-1
  130 READ(5,9002) INEL,IINC
      IF(IINC.EQ.0) IINC=1
```

```
 9002 FORMAT(I5,15X,I5)
      READ(5,9004)(INP(I),I=1,8)
 9004 FORMAT(8I5)
  140 NEL=NEL+1
      ML=INEL-NEL
      IF(ML)150,155,160
  150 CALL ERROR(8)
C *** NO GENERATION OF NODE POINTS REQUIRED
  155 DO 156 I=1,4
         I5=I+4
         I9=I+8
         NP(I)=INP(I)
         NP(I5)=0
         NP(I9)=INP(I5)
  156    CONTINUE
      GO TO 162
C *** GENERATION OF NODE POINTS REQUIRED
  160 DO 161 I=1,N12
         IF(NP(I).EQ.0) GO TO 161
         NP(I)=NP(I)+KN
  161    CONTINUE
  162 CONTINUE
      NUMEL=NUMEL+1
      WRITE(10) N12,NEL,(NP(I),I=1,N12)
      IF(NEL.EQ.NPAR(2)) RETURN
      IF(NEL.LT.INEL) GO TC 140
      KN=IINC
      GO TO 130
      END
      SUBROUTINE AD3DEE
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** THIS SUBROUTINE TO READ ADINA 3-D SOLID ELEMENT DATA
C *** THIS ROUTINE CALLED BY ELTYPE
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/GCONT/NUMNP,NFAR(20),NELTYP,NUMEL
      DIMENSION NP(20),INP(20)
      NUMMAT=NPAR(16)
      NSTRES=NPAR(13)
C *** CALCULATE THE NUMBER OF MATERIAL CASE CARDS
      IF(NPAR(15).EQ. 1) NCARD=1
      IF(NPAR(15).EQ. 2) NCARD=2+NPAR(18)
      IF(NPAR(15).EQ. 3) NCARD=4
      IF(NPAR(15).EQ. 4) NCARD=4
      IF(NPAR(15).EQ. 5) NCARD=2
```

```
      IF(NPAR(15).EQ. 8) NCARD=1
      IF(NPAR(15).EQ. 9) NCARD=1
      IF(NPAR(15).EQ.10) NCARD=6
      IF(NPAR(15).EQ.11) NCARD=6
      IF(NPAR(15).NE.12) GC TO 20
      CARDNR=NPAR(17)/8.0
      NCARD=INT(CARDNR)
      TEST=CARDNR-NCARD
      IF(TEST.GT.0.1) NCARD=NCARD+1
   20 CONTINUE
      N20=20
C *** READ MATERIAL PROPERTIES
      DO 50 J=1,NUMMAT
         READ(5,9000) DUMMY
 9000 FORMAT(20A4)
         DO 45 I=1,NCARD
            READ(5,9000) DUMMY
   45       CONTINUE
   50    CONTINUE
C *** READ STRESS OUTPUT TABLE CARDS
      IF(NPAR(13).EQ.0) GC TC 61
      DO 60 I=1,NSTRES
         READ(5,9000) DUMMY
   60    CONTINUE
   61 CONTINUE
      IF(NPAR(14).EQ.0) NPAR(14)=1
      NEL=NPAR(14)-1
  130 READ(5,9002) INEL,IINC
 9002 FORMAT(I5,30X,I5)
      IF(IINC.EQ.0) IINC=1
      READ(5,9004) (INP(I),I=1,8)
      READ(5,9004) (INP(I),I=9,N20)
 9004 FORMAT(12I5)
  140 NEL=NEL+1
      ML=INEL-NEL
      IF(ML) 150,155,160
  150 CALL ERROR(9)
C *** NO GENERATION OF NODE POINTS REQUIRED
  155 DO 156 I=1,N20
         NP(I)=INP(I)
  156    CONTINUE
      GO TO 162
C *** GENERATION OF NODE PCINTS REQUIRED
  160 DO 161 I=1,N20
         IF(NP(I).EQ.0) GC TO 161
         NP(I)=NP(I)+KN
  161    CONTINUE
  162 CONTINUE
```

```
      NUMEL=NUMEL+1
      WRITE(10) N20,NEL,(NP(I),I=1,N20)
      IF(NEL.EQ.NPAR(2)) RETURN
      IF(NEL.LT.INEL) GO TC 140
      KN=IINC
      GO TO 130
      END
      SUBROUTINE ADBEAM
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** THIS SUBROUTINE TO READ ADINA 2NODE BEAM ELEMENTS
C *** THIS ROUTINE CALLED BY ELTYPE
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/GCONT/NUMNP,NPAR(20),NELTYP,NUMEL
      N2=2
      NUMMAT=NPAR(16)
      IF(NUMMAT.EQ.0) NUMMAT=1
C *** READ MATERIAL PROPERTIES
      DO 50 J=1,NUMMAT
         DO 45 I=1,2
            READ(5,9000) DUMMY
 9000 FORMAT(20A4)
   45       CONTINUE
   50    CONTINUE
C *** READ STRESS OUTPUT TABLE CARDS
      IF(NPAR(13).EQ.0) GO TO 81
      IF(NPAR(14).EQ.0) NPAR(14)=16
      NST=NPAR(13)
      CARDST=NPAR(14)/16.0
      NCDST=INT(CARDST)
      TEST=CARCST-NCDST
      IF(TEST.GT.0.01) NCDST=NCDST+1
      NST=NST*NCDST
      DO 80 I=1,NST
         READ(5,9000) DUMMY
   80    CONTINUE
   81 CONTINUE
C *** READ OR GENERATE ELEMENT DATA CARDS
      IF(NPAR(17).EQ.0) NPAR(17)=1
      NEL=NPAR(17)-1
  130 READ(5,9002) INEL,II,JJ,IINC
 9002 FORMAT(3I5,15X,I5)
      IF(IINC.EQ.0) IINC=1
  140 NEL=NEL+1
      ML=INEL-NEL
```

```
      IF(ML) 150,155,160
  150 CALL ERROR(10)
C *** NO GENERATION OF NODE POINTS REQUIRED
  155 I=II
      J=JJ
      GO TO 162
C *** GENERATION OF NODE PCINTS REQUIRED
  160 I=I+KN
      J=J+KN
  162 CONTINUE
      NUMEL=NUMEL+1
      WRITE(10) N2,NEL,I,J
      IF(NEL.EQ.NPAR(2)) RETURN
      IF(NEL.LT.INEL) GO TO 140
      KN=IINC
      GO TO 130
      END
      SUBROUTINE GEOM2(NUMFT,XPT,YPT,ZPT,UPT,VPT,WPT)
      CALL ERROR(14)
      RETURN
      END
      SUBROUTINE NSTRUS
C
C *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *
C
C *** THIS SUBROUTINE TO READ NON SAP TRUSS ELEMENTS
C *** CALLED BY ELTYPE
C
C *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *
C
      RETURN
      END
      SUBROUTINE NSPLAN
C
C *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *
C
C *** THIS SUBROUTINE TO READ NON SAP 2 D 8 NODE PLANE ELEMENTS
C *** CALLED BY ELTYPE
C
C *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *
C
      RETURN
      END
      SUBROUTINE NS3DEE
C
C *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *     *
C
C *** THIS SUBROUTINE TO READ NON SAP 3-D ELEMENT DATA
```

```
C *** CALLED BY ELTYPE
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      RETURN
      END
      SUBROUTINE DATA1(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
C *** CALLED BY PSAP1
C
      RETURN
      END
      SUBROUTINE DATA5(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT)
C
C *** CALLED BY PSAP1
C
      RETURN
      END
      SUBROUTINE DATA9(NUMPT,XPT,YPT,ZPT,UPT,VPT,WPT,DISPD,NON)
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
C *** USER SUPPLIED DISPLACEMENT INPUT SUBROUTINE.
C *** CALLED BY PSAP1
C
C *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *
C
      COMMON/CDATA/NTIME,NTLC
      COMMON/CONTRL/ KGEOM,KDATA,KPLOT,KSYMXY,KSYMXZ,KSYMYZ,NOTAT,XLHT,
     1KHORZ,KVERT,PHI,THETA,PSI,NEWFR,ISCALE,PLOTSZ,XORGN,YORGN,
     2PSCALE,KDISP,DMAG,KODE
      COMMON/KOUNT/ NNODE,NNDEST,NUDISP,NVDISP,NWDISP
      DIMENSION NUMPT(1),XPT(1),YPT(1),ZPT(1),UPT(1),VPT(1),WPT(1)
      DIMENSION DISPD(5,3,NCN)
C
      IF (NUDISP.EQ.0.AND.NVDISP.EQ.0.AND.NWDISP.EQ.0) GO TO 25
      IF(NTIME.NE.0) GO TO 100
      READ(5,1000) NTLC,SCALEF
 1000 FORMAT(I5,F10.0)
      IF(SCALEF.EQ.0) SCALEF=1.0
   10 READ(5,2000) N,NLCAS,U,V,W
 2000 FORMAT(2I4,3E12.5)
      DISPD(NLCAS,1,N) = U*SCALEF
      DISPD(NLCAS,2,N) = V*SCALEF
      DISPD(NLCAS,3,N) = W*SCALEF
      IF( (NLCAS.EQ.NTLC).AND.(N.EQ. 1    ) ) GO TO 100
      GO TO 10
  100 NTIME = NTIME + 1
```

```
200 DO 20 I=1,NNODE
    UPT(I) = DISPD(NTIME,1,I)
    VPT(I) = DISPD(NTIME,2,I)
    WPT(I) = DISPD(NTIME,3,I)
 20 CONTINUE
25  CONTINUE
    RETURN
    END
```

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